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HOW
TO

MAKE ANYTHING

See how they made this amazing
**3D
PRINTED
CAR**
PAGE 72



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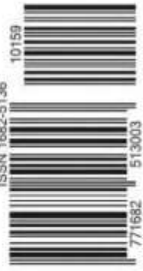


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Cover: We still build cars the way we did a hundred years ago and there are those who say change can't come too soon. Well, that change is already here, in the shape of the Strati, the first 3D-printed car. We even take it for a test drive; see page 72. **Opposite page:** Making. It's what we do; see pages 72 and 90.



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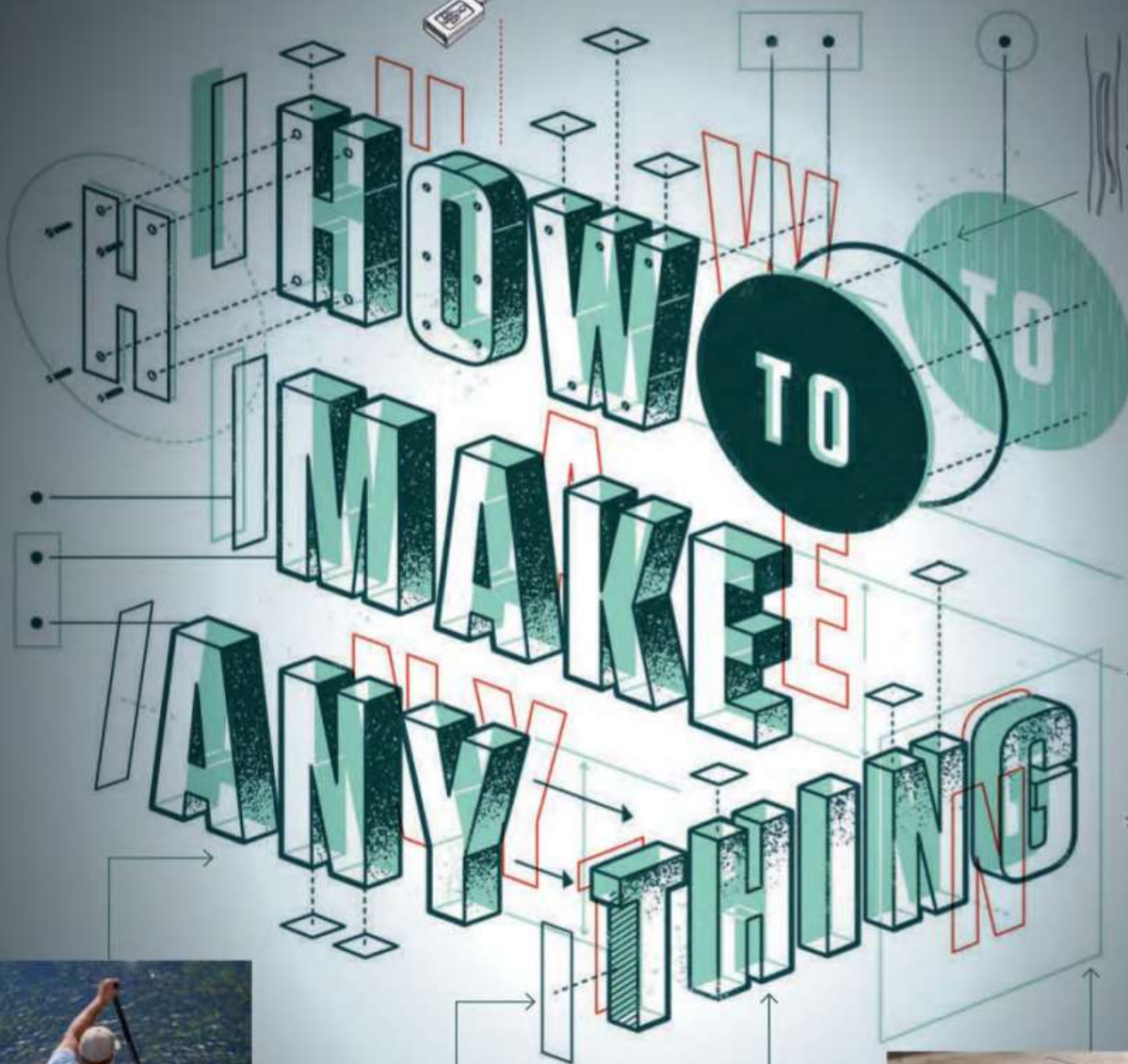
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FOR OUR CURRENT SUBSCRIPTION RATES, SEE PAGE 40

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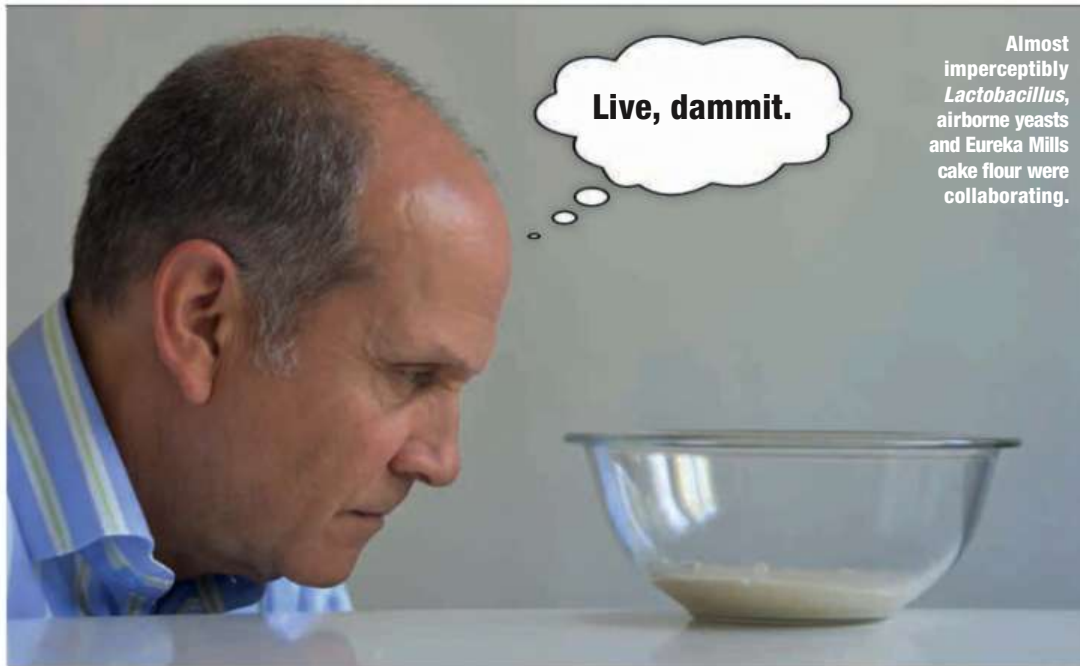


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Almost imperceptibly *Lactobacillus*, airborne yeasts and Eureka Mills cake flour were collaborating.

FUTURETECH

Circumstances beyond our control have forced us to postpone FutureTech – scheduled for October 2015 – to, provisionally, the first quarter of 2016. Our apologies; we'll keep you informed of developments (and a date) at the earliest opportunity.

MAKING IT

By Day 5, signs of real life were apparent. The first faint pinpricks in the sea of off-white had given way to something approaching the real McCoy: actual bubbles.

Almost imperceptibly *Lactobacillus*, airborne yeasts and Eureka Mills cake flour were collaborating in that familiar biochemical reaction. The ancients in the Fertile Crescent thousands of year ago, so it's said, knew it.

My sourdough culture wasn't quite that old. But it seemed to have survived weeks of neglect in the fridge. In the absence of its regular twice-daily feeding, it had gone to sleep, fortunately not eternally. Despite the faint signs of mould around the edges. It still wasn't quite ready for full-on baking duty, but that would come.

In the case of my culture we are, after all, talking about a living thing that turned 7 on 1 May. That's the 7th anniversary of my first successful loaf, by the way.

You see, I too am a maker. With an M, not with a B.

Until the Cape Town Maker Faire this past August, I might not necessarily have considered myself to be one. But the emcee's remarks at the opening ceremony got me thinking. Making, he said, embraces all kinds of stuff. Why, he himself fell into making through his interest in cooking.

Hey, that makes me a maker, too, I thought.

If you'd then wandered through the exhibits as I did, you would have noticed that making is about a lot more than 3D printers. It's about repurposing worn-out appliances. Cultivating worm farms. Being patiently talked through the intricacies of

3D printing by a clued-up, terribly serious exhibitor whose voice hadn't yet broken.

And baking.

To explain: the Faire was an opportunity to meet up once again with a very Pop Mech kind of guy, Billy Hadlow. We have featured Billy's ingenious, award-winning portable electricity initiative (khayapower.org) online. Billy hasn't stopped there: at the Faire, he was showing off his FAABulous stove. It's a fan-assisted gasifier design. If its modular construction looks sort of familiar (see picture), think paint tin. The way he describes it, inside the metal container fuel is converted into combustible gases through intense heating. These gases are then burnt with a clean flame. "The design allows for cleaner, safer and more cost-effective cooking than traditional paraffin stoves," says the citation prepared for Inventors' Garage competition at the recent SA Innovation Summit, where Billy's stove was one of the finalists.

Powered by renewable energy or a 220 V mains source, its key market is peri-urban and rural areas where cooking is typically done using firewood, charcoal or paraffin. It can be powered by various combustible agricultural materials. Assembly takes place in mini-factories that require no Eskom power (!), providing job opportunities and flexible distribution. It's more than just a stove, too: it can be used to power an LED light, operate a small oven, charge your phone and it can be turned into a food dryer.

And it can bake.

"I can fit a loaf tin in there," Billy says. "An hour later..."

Makers are bakers. Bakers are makers, too. Let's get making.



Anthony

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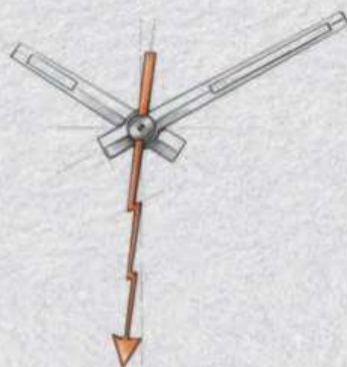
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USING WEARABLES TO SAVE LIVES

WINNING LETTER

I am a final year mechatronics engineering student at the University of Stellenbosch busy finishing my undergrad thesis, "Gimbal Control by Means of Google Glass". The purpose of my project is to give a search and rescue field operator the ability to have a second pair of infrared eyes in the sky (mounted on an aerial quadcopter platform) when out on a mission in the mountains, searching for a person in distress. The Google Glass is used to control the 3-axis gimbal (which I designed and 3D printed) by means of natural head movements. Essentially this mimics the head movements of the operator and looks in the same direction as he does. The reason for using Google Glass



as opposed to another wearable is its unobtrusive Head Up Display. This allows the search and rescue operator to scour the mountainside and control the gimbal's view, hands-free.

I have achieved successful results and I am in the process of designing a location tracking algorithm as well.

As an avid reader of PM for the past 10 years, I would love to read an article about how wearable

tech, especially something such as Google Glass (which is under scrutiny as an "overpriced gadget") could be used to save lives. That would be very useful in South Africa, where mountain rescue services conduct hundreds of operations annually with huge helicopter deployment expenses. Theoretically this system could drastically increase the efficiency of a single search and rescue operator in the field and lessen the costs incurred.

J BLOM

STELLENBOSCH UNIVERSITY

Write to us, engage us in debate and you could win a cool prize. This month's best letter will receive a **HTSE** watch developed by **TITAN**, valued at R3 750. **HTSE**, or High Tech Self Energized, is a collection of futuristic, light-powered watches developed by **TITAN**. These watches can be charged by any light upwards of 200 Lux. **HTSE**'s design inspiration is from some of the most complex self-energising bodies built by mankind: space ships, orbiting space stations and satellites.

HTSE watches' impressive array of features includes End of Life (an indicator of battery charge), Sleep Mode (increases shelf life of the battery) and Over Charge Prevention (protects the battery). **HTSE** – for those driven by technology. To find out more, contact Luxco on 011 448 2210 or www.luxco.co.za

Send your letter to: **POPULAR MECHANICS**, PO Box 180, Howard Place 7450, or e-mail popularmechanics@ramsaymedia.co.za Please keep it short and to the point. Regrettably, prizes can be awarded only to South African residents.

AI: OUR LITTLE HELPER

Having recently developed a thirst for knowledge, information and perhaps even being so bold as to suggest wisdom, we've opened ourselves to digital media of all forms. For the most part, we're left with umpteen unread notifications and accounts we don't have time to browse, and a general information overload headache. Here's where the potential beauty of AI comes into its own. Current infantile AI is limited to either programmed responses to questions or linking accounts and mining online search engines.

In the near future, this could include not only data on what you want and when, but the AI would also "know" under what circumstances certain information would become relevant by integration in say, wearable tech, GPS and browsing habits. Furthermore, AI could detect anomalous readings in vitals and emotional state, responding with real-time usable information to help either solve the (emotional or health) issue, or alternatively seek out appropriate assistance and connect them autonomously with the end-user. Thinking even further down the line, AI could even act as a basic form of companionship for those based in remote work locations, apart from friends or family through digital avatars that recognise, and replicate verbal tones or facial cues.

In summary, and ignoring the doom-and-gloom propaganda brought about largely through Hollywood hype as well as data security and the uncertain effect on social interaction with friends and family, AI could serve as:

- Digital assistant and information organiser, as well as
- An emotional and medical caregiver.

Anyone who currently lives a modern "connected" and active work life, must at some point have realised that there are simply times when you can't or just plain won't "adult", and this is where AI could serve best.

DAMIEN COULSON
CLARENS

THE REAL ENERGY DEBATE

A recent article in *Wattnow*, the journal of the SAIEE (SA Institute of Electric Engineers), pretty much sums up what I have been saying for years.

The knee-jerk reaction to the country's electrical supply debacle has been renewables. The result has been to let the government off the hook from spending the necessary billions on coal or nuclear power stations. Yes, even with the best batteries yet to be invented for the big PV or wind farms, but too costly for the householder, this source



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is but a percentage of our energy requirements, now and in the future.

The debate should be between coal and nuclear with a smidgen of undersea gas.

Coal can be made clean, as Germany has proved. The debate on coal, however, is totally obfuscated by our export policy to both India and China.

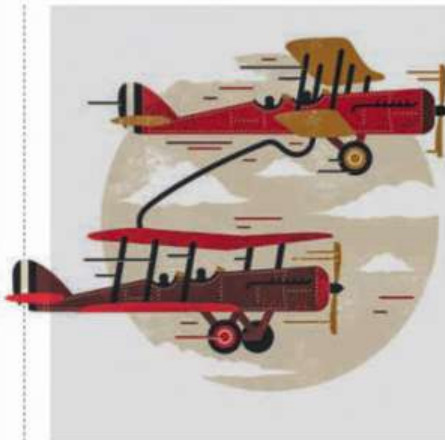
It is a case of export first, at the lowest prices, and local use second, at the much higher prices. This is why government is forced to bail out Eskom.

This is why we have load shedding at totally off-peak periods – to save coal, not because of lack of capacity alone.

As for nuclear, that debate is not over. Beautiful, clean – but expensive – power. What happens to the waste? Bury it to allow our grandchildren to solve the problem? And Russia: are we wooing a known “dicey safety record supplier” for political expediency?

Let us not back bicycles towing cement trucks, but debate the real issues

FRANK VAN DER VELDE, PR ENG, MSAIEE
DEVIL'S PEAK



ACTUALLY, A BRIT DID IT

Refuelling in the air (Great Unknowns, August) was, to my understanding, invented by Sir Alan Cobham.

Sir Alan was also the first pilot to fly a sea-plane around Africa, together with his wife. He owned an island in the Virgin Island named Peter Island and his son Jeffrey had a boat business in Tortola. Additionally I believe he also had a small farm North of Himeville, near Sani Pass, dealing in cotton.

ALAN C EVANS
(RETIRED AIRLINE CAPTAIN)

BASHING RUSSIA

I was surprised to note the Russia-bashing stance taken in the article on how to win an artillery war (HYWW, July). A government emerging from a fascist right wing-backed coup that attacks with heavy weapons its own cities, civilian objects and citizens, human beings of another home language who seem merely to want to enjoy a similar

form of governance to that which the people of Quebec in Canada enjoy, leaves me wondering whether there is some other motive afoot.

Maybe all this drum-beating is an attempt to keep the EU and Russia apart, for such a union would seriously threaten the balance of power in the world. As for the Putin insert on page 15, it seems to me to be a cheap shot by the owners of the parent media striving to serve a political master. We all know how hard the Russian foreign office has worked to keep the peace in the world, inter alia successfully blocking an all-out war in Syria.

As for firing lasers at unmanned weapons, how long will it be before such directed energy weapons are fired at manned weapon systems, perhaps powerful enough to blow a pilot's head off? Anything less powerful would sail very close to the wind of Geneva's Protocol IV to the Certain Conventional Weapons Convention prohibiting blinding laser weapons.

I would suggest certain elements of the media and their political masters stop trying to create an evil genie in a bottle based on a real-world country to test political formulae and weapon concepts against. One might just be created and it might just smash its way out of the bottle during some winter storm.

NIGEL APSEY
CENTURION

AS THE ARTIST INTENDED

Johann Myburgh (Letters, September 2015) posed two questions.

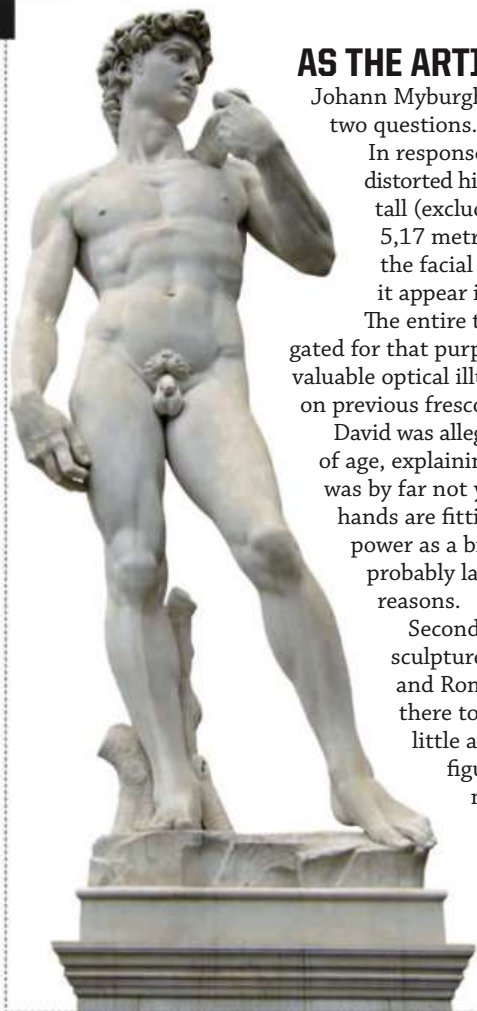
In response, firstly Michelangelo calculatingly distorted his David, standing more than 4 metres tall (excluding the plinth – total height is 5,17 metres) to make the figure, especially the facial expression, visible and to make it appear in proportion from ground level.

The entire top half of the body has been elongated for that purpose. Michelangelo clearly gained valuable optical illusion experience when he worked on previous frescoes.

David was allegedly a young male of about 15 years of age, explaining the slightly over-size hands. He was by far not yet a fully developed man. The large hands are fittingly symbolic of his strength and power as a biblical hero. The feet and ankles are probably larger for practical weight-bearing reasons.

Secondly, the David marble nude is a sculpture in the Classical tradition (Greek and Roman) and the genitals are simply there to confirm the gender and to draw as little attention as possible. A circumcised figure would have been historically more realistic; then again, surely he would have dressed in sandals and a basic robe before his appointment with Goliath?

HUGO DE VILLIERS
CAPE TOWN



GET THE RIGHT INVERTER

In reply to a comment about shortening the lifespan of uninterrupted power supplies (Letters, September), most UPSs do not have any cooling fans and are designed to run for a minimum time before they over-heat and turn themselves off. You need a dedicated inverter that is designed for long-term use.

COLIN MEYEROWITZ
BY EMAIL **PM**



Can you really rely on a substitute?

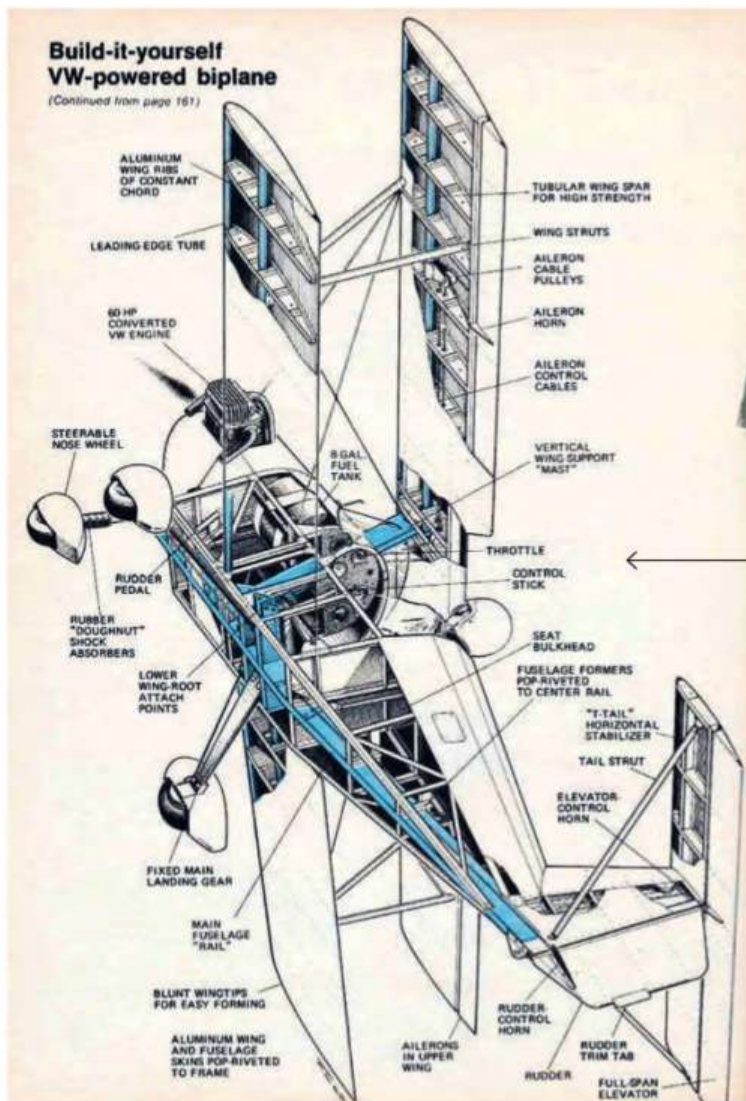
A substitute just doesn't work as well. Choose the part that was made for the job, ask for Volkswagen Genuine Parts. Volkswagen Genuine Parts guarantee the highest quality standard for optimum performance and impeccable safety, ensuring that your car performs exactly as it should.



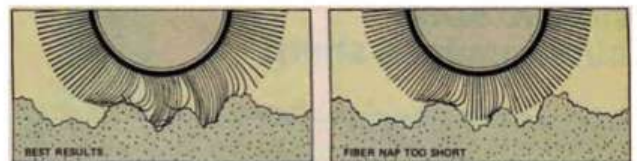
DECEMBER 1973

Different eras have different ways of doing things. In 2015, we communicate by email, Twitter, Wi-Fi, Bluetooth and 4G. In 1973, we communicated by cupping our hands either side of our open mouths and yelling, along with 40 000 others, "Ref, are you blind or what?" Which only goes to show that, although the medium may change, the message often stands the test of time.

In that vein, and given that this issue is heavily biased towards doing it yourself, we had a look at what DIYers were doing 42 years ago.



"Build this VW-Powered plane and be flying in six months," our cover promised. The open biplane Aerosport Scamp and the closed-cockpit high-wing Quail version were aimed specifically at homebuilders. By the mid-1990s, more than a thousand sets of plans had been sold. It all seemed straightforward, except for an ominous warning from designer Harris "Woody" Woods – in italics, for emphasis – that it was *absolutely essential* that the engine used be converted for aviation use. Given the separate feature about homebuilt rotorcraft a few pages earlier, it's clear designers envisaged skies filled with the clatter of VW flat-fours and the unnerving sight of flocks of whirlybirds dodging each other like so many giant dragonflies. We suspect all this might have been simply too much for the fevered imagination of writer-turned-pilot Joshua Ferris (his final instalment of "Learning to fly" starts on page 62).



Sharpening

In the era of power tools to suit every occasion, there's a certain charm in pondering the finer points of maintaining hand tools, as we did in "How to keep cutting edges sharp".

With that in mind, let's put something out there: write in and tell us about the oldest tool in your toolbox. There's a prize on offer for the best letter.



Painting

Today's DIY enthusiast seems to spend more time matching computer-generated paint colours than actually slapping the stuff on walls. Back in 1973, the home painter grappled with such issues as how to pick the right roller. It couldn't have been easy, either: the how-to-choose-rollers chart is of a complexity not normally seen outside an unabridged Swiss railway timetable. **Pro tip:** avoid holidays. If the roller's fibres are too short for a rough-textured surface, you will see show-throughs – commonly called holidays. Just so you know.

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THE GREAT WORLDWIDE CANAL RACE

The two most famous canals – and an upstart – battle to move the biggest ships in global trade.
BY KEVIN DUPZYK

IN 1984, ABOUT A MILLION TONS OF CARGO passed through the Suez Canal every day. Last year that number was up to 2,6 million. Over the same period, the number of ships traversing the canal every day dropped, from more than 21 000 to about 17 000. How? The ships got bigger. The highest-capacity container ship at sea today holds more than four times as much cargo as the record holder in 1984. With global demand for imported goods increasing, companies employ the cost-effective strategy of cramming everything on large vessels and making fewer trips.

Problem is, the Suez Canal and its western hemisphere counterpart, the Panama Canal, were not designed to accommodate enormous

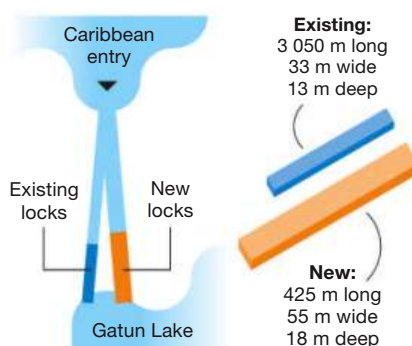
Since this photo of the Panama Canal's new Atlantic lock was taken (last December), engineers have allowed water to enter the structure.

ships, which have grown in three measurements: length, width (called beam), and depth in the water (draught). Both canals are scrambling to accommodate the deeper drafts of megaships, which can reach more than 15 metres. The Suez's main canal can move behemoth container ships, with beams up to 50 metres, but only in one direction at a time. Panama's famed lock system is too small in all three dimensions. Built in 1869 and 1914, respectively, both waterways require updates if they're to remain competitive with each other. And with a new canal scheduled to open in Nicaragua within the next five years, they need to act quickly. Lucrative shipments from Southeast Asia to American ports on the Gulf of Mexico and the East Coast could travel on any of the three routes.

The Panama Canal has aged more poorly because of its dependence on locks, which raise ships 26 metres on entry and lower them back to sea level at the exit. The current locks can handle ships with capacities of up to 5 000 20-foot (6-metre) equivalent units (TEUs, each about the size of a half-length semitrailer). The world's largest container ship, the MSC *Oscar*, carries nearly 20 000 TEUs. To expand the canal, workers are deepening and widening the existing route and constructing new locks from 16 rolling metal gates. When

PANAMA'S NEW LOCKS

New lock complexes on both ends of the canal will allow bigger ships to enter and exit.

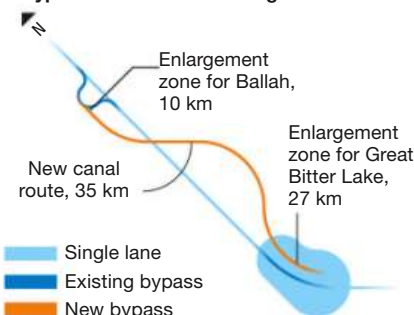


completed in April 2016, the new Panama Canal will be able to handle ships of up to 13 000 TEUs – ships longer than a Manhattan city block, with an eight-storey building of containers piled on deck.

Suez is simpler, lock-free, and large enough to handle oversize ships, but only if they transit in convoys, with bypasses allowing the convoys to pass one another. To allow more room, workers are digging a new canal parallel to 35 kilometres of the existing one and expanding the current bypasses. The result will be a new 72-kilometre lane, expected to open this month, that should

SUEZ'S PASSING LANE

Convoys coming from opposite directions use two bypasses to transit the single-lane canal. The new canal combines those bypasses into a 72 km-long second lane.



reduce ships' journeys by at least 12 hours.

Even when the revisions are complete, however, both Suez and Panama will still be limited. Panama's new locks won't be able to handle ships the size of the *Oscar*, and Suez will still be mostly one-way. This is what makes the Nicaragua contender so potentially world-changing. In December 2014, a Chinese company, HKND Group, announced a design for a canal that could handle all of today's megaships. A route has already been selected – about 500 kilometre, north of the canal in Panama. The Nicaraguan Government has given its blessing.

Plenty of people, including Eric Farnsworth, vice president at the Council of the Americas, an organisation that supports business development in the western hemisphere, are dubious that the Nicaragua Canal will actually be completed, freighted as it is with economic and political baggage. But grant that it's up and running in five years, as HKND Group claims, and suddenly the Panama Canal would have to compete directly with a canal built using an additional century's worth of technology.

Last September Egypt commemorated its Suez Canal project with a set of stamps. One depicted the Panama Canal. To Egyptians it was an honest mistake. To Panamanians, a laugh. To the Chinese, prescient. Consumers don't care. To most of us, canals, like stamps, are just a means to get stuff. To the countries that design and maintain the mighty canals of the world, a single waterway can contribute between 2 per cent (Egypt) and 6 per cent (Panama) to the economy. Their demise could destabilise a nation. You can be sure the race to improve their technology will be heated.

HOW TO CHOOSE A SHIPPING ROUTE

When planning a trip from a Vietnam factory to a Chicago store, a hypothetical shipper must consider many factors, including tariffs, canal fees, boat size, load size, and required unloading equipment.

ROUTE 1

In the simplest case, a boat could travel direct from Ho Chi Minh City to Tacoma and take a train from there:

18 days to Tacoma
3 days unloading
4 days 12 hours by rail
TOTAL: Approx. 25.5 days

ROUTE 2

If the load requires specialised unloading equipment that's not available in Tacoma, it might transit to Houston via Panama:

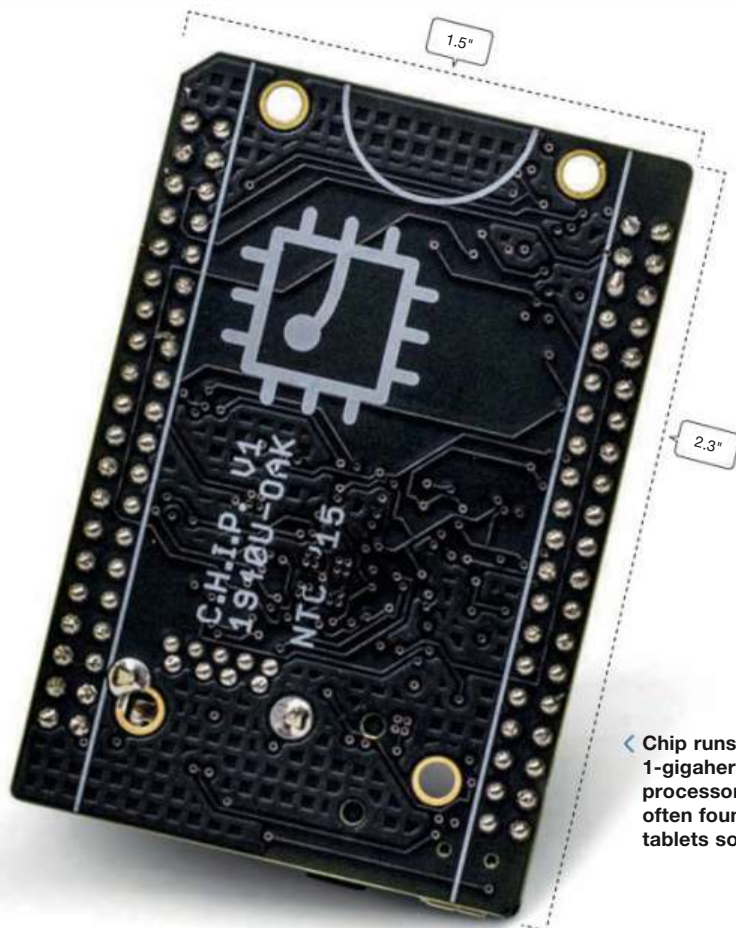
6 days to Shanghai
2-day layover
23 days to Houston
1 day unloading
3 days 1 hour by rail
TOTAL: Approx. 35 days

ROUTE 3

Unless the boat's too big to fit, in which case it might take a westerly route to Newark through the Suez:

36 days to Newark
2 days unloading
2 days 17 hours by rail
TOTAL: Approx. 41 days





◀ Chip runs on a 1-gigahertz R8 ARM processor, the kind often found in cheap tablets sold in China.

CONVERSATION STARTERS FOR NERDS

Apple initially resisted turning the logo on its laptops upside down (so it's upright when open) because the designers thought people would try to open the shell the wrong way.

release an even cheaper version: Chip, a credit-card-sized circuit board. The price: nine dollars (R100).

Chip feels egalitarian. Rebellious, even. The engineers, known collectively as Next Thing Co, are working with a manufacturer of inexpensive Chinese semiconductors to sell the computers for next to nothing, with the goal of reaching the greatest number of dreamers who might create a new product. An enterprising maker could use Chip to do any number of the things computers do: retrofit cabinet speakers to blast a playlist, build a Super Nintendo, or make appliances turn on and off with the sound of his or her voice. With the addition of a few sensors, a Chip could be made into a biometrics monitor that sends patient data over Wi-Fi.

But there is always a "but". Chip runs Debian Linux, a free operating system maintained by programmers working pro bono for fellow builders. Debian Linux is complicated enough that Chip's developers anticipate a learning curve. "Chip ships with Scratch, a learn-to-code software," says industrial designer and Next Thing Co founder, Thomas Deckert. With access to YouTube tutorials and a second computer for copying and pasting large chunks of code, sure, a determined amateur could learn quickly. Anyone else is in for a lot of work.

So what will Chip do for those of us who are content to interact with icons and pull-down menus? It's unlikely to bring modernity to impoverished areas – the Wi-Fi-equipped boards need infrastructure to function. It's not durable enough to be used in commercial devices, either. The hope is that by untethering technological innovation from the need for heavy investment, Chip will create more makers. "You can make prototypes that you may turn into a business," says Stuart Lipoff, a consumer electronics consultant for the US Institute of Electrical and Electronics Engineers. "Chip enables a broader range of creative minds to come up with ideas." So even if you're not the one actually writing the code for an industry-changing medical diagnostic device or an app-activated security system, there is a solid chance that some kid out there with a garage, a little coding ability, and 100 bucks will use Chip to create something that will make your life better.

CAN A R100 COMPUTER CHANGE THE WORLD?

Call it the microwave effect: a newer, cheaper circuit board could democratise computer-powered devices.

All it needs are a few determined handlers.

BY ALEXANDER GEORGE

IF YOU DISTILL A COMPUTER DOWN to its essential parts, there's not much there. Get rid of the display, the casing, and all the software, and you're left with a central processing unit, some memory, and a few familiar ports: a scary-looking board most of us wouldn't know what to do with. In 2012, the world was introduced to the Raspberry Pi, a stripped-down computer that sells for around R500. Later this year a group of engineers in Oakland, California, will



FANCY WATCHES GET SMART A smart watch may help you get in shape and sleep better, but underneath a fancy cuff link, a beeping, glowing bracelet can look... out of place. So, for people who want to record their footsteps while attending a black-tie benefit, several classic watch brands have now fitted transmitters and activity sensors, the same found in Jawbone's and Nike's fitness trackers, into traditional analogue designs. Quartz models from Frederique Constant, Alpina and Mondaine look like heirloom timepieces, but they can count steps, send the information to your phone, and wake you up with a silent vibration alarm. Best of all, with no big display to power, the batteries last two years before they need to be replaced.



HOW TO USE ACID*

Bartenders are experimenting with new ways to manipulate a classic cocktail element. You can, too. BY PETER MARTIN

THERE'S A REASON A DAIQUIRI TASTES GOOD and Long Island iced tea tastes terrible: balance. (Also: self-respect.) Of the many, many ways a cocktail can go wrong, poor acid balance is among the most common. In the case of sours, Collinses, and smashes, three types of cocktails that rely heavily on citrus, it's a bartender's job to make sure the liquor, sugar and acid play well together. It's like a boozy game of rock-paper-scissors in which you're always pulling for a tie.

Though every cocktail and, in fact, every bartender, is a little different, the ratio of two parts liquor to one part sour to one (or one-half) part sweet is a common one for

**IN A COCKTAIL. THIS ISN'T THAT KIND OF MAGAZINE.*

THE BURNT LIME GIMLET

Place a halved lime in an ungreased pan cut-side down over high heat. Sear until the sliced ends are caramelised, about 3 minutes. Juice the lime while it's still hot and run the juice through a double tea strainer, then a wet coffee strainer, to clarify. Pour 30 ml lime juice, 60 ml Hayman's Royal Dock Navy Strength gin, 15 ml simple syrup, and a dash orange bitters into a cocktail shaker with ice and shake. Strain and serve in a martini glass.

sour-style drinks such as the daiquiri and the margarita. The acid brightens the drink, making it feel more refreshing and less heavy. According to Darcy Gentleman at the American Chemical Society, along with counteracting sugar so that the drink isn't too sweet, acid helps flavours blend in alcoholic drinks. If you want to taste all the flavours in every sip, you need a little acid.

Learning how and in what ratio to pair sour juices with liquors has always been a primary challenge of bartending. Lemons have a stronger flavour than limes, and pair well with beefier base notes – rye whiskies and punchier gins. Orange and grapefruit juices contain sugar as well as acid, and can replace elements of both sweet and sour. You could rim a glass with powdered citric acid. You could replace juices with so-called drinking vinegars (also known as shrubs) to add acetic acid instead of the acids common in citrus fruits. You could replace the sweet element with liqueurs. The only thing you can't do is ignore the acid-sugar balance.

You can even change the acids themselves. That's why Todd Maul, bar director and partner at Café ArtScience in Cambridge, Massachusetts, decided to buy a centrifuge. After a few minutes at 10 000 r/min to skim out the impurities and sediment, Maul says, his lime juice is lighter, brighter, and drier-tasting. It lasts six times as long in the refrigerator. What you get is clarified lime juice, with the extreme sour notes removed. This reduces the need for complementary sugars, allowing for more of the liquor's base flavour to shine through. Which means you get a mellower drink. "It's like listening to Miles Davis instead of the Ramones, where everyone is playing as loud as they can to be heard," Maul says. "You don't have to fight with it."

You could buy your own centrifuge (about R3 000 on eBay), but Maul has an easier way to change the effects of your acids at home. Sear your limes in a pan, then juice them and pass the juice through a coffee strainer to remove any solids. By adding heat, you're caramelising the natural sugars in the limes to counter the acidity. This also adds an earthy, smoky flavor – possibly the key to your new signature gimlet.

THINGS YOU MIGHT ENCOUNTER AT THE BAR: CANE-JUICE EXTRACTOR



Order a mojito at Asia de Cuba restaurant in New York City and you may notice a 45-kg machine whirring away behind the bartender. This is the bar's sugarcane-juice extractor, which uses three rotating cylinders to crush an a 20-centimetre stalk of sugarcane into 60 millilitres of juice in just five seconds. The bar uses this juice, which has a vegetal, diluted sweetness similar to that of coconut water, in addition to simple syrup. It adds both sugar and flavour to cocktails, and gives customers something to talk about. – KATIE MACDONALD

A BETTER JAIL

The latest group to try to fix the broken penal system in the US is... architects?

I F YOU'VE EVER BEEN TO LAS VEGAS, you know that environment can manipulate behaviour, encouraging you to stay out later or spend more money without realising it. It's the same in prison: depressing conditions and a draconian culture can encourage poor behaviour, which leads to longer punishments – at taxpayers' expense. Prison is meant to deter crime, not foment it. For this reason, two US architecture firms, KMD and HMC, used design principles from universities and hospitals to build a women's jail in San Diego, California that could reduce assault, vandalism and, eventually, recidivism. "It's not nice. It's not like you're in a luxury hotel," says Richard Wener, an environmental psychologist at New York University. "But there are colours. There's furniture. It says, 'We expect you to treat this place with respect. If you don't, you won't be able to stay here.'" Though the R3 billion Las Colinas Detention and Reentry Facility's first phase has been open for only a year, both inmates and staff have already reported positive responses to the design. Here's how the architects did it. – JACQUELINE DETWILER

1. Large windows

Both natural light and views of the outdoors reduce stress, according to environmental psychology studies. Lack of light may contribute to insomnia and mood disorders in prison populations, which can lead to behavioural problems that might not have manifested otherwise.

2. Sound attenuation

The architects worked with an acoustics expert to reduce noise and echoing in common areas, which can increase stress and confrontations. This was especially important in the cafeteria, where suspended "acoustical clouds" high above the tables muffle noise. "There's evidence that the effects of stress are cumulative," says Wener. When you've got lack of sleep, bad odours, insufficient light, and constant noise, the noise is an easy first target.

3. Campus-style housing

Living areas in the jail's lowest-security settings look much like a

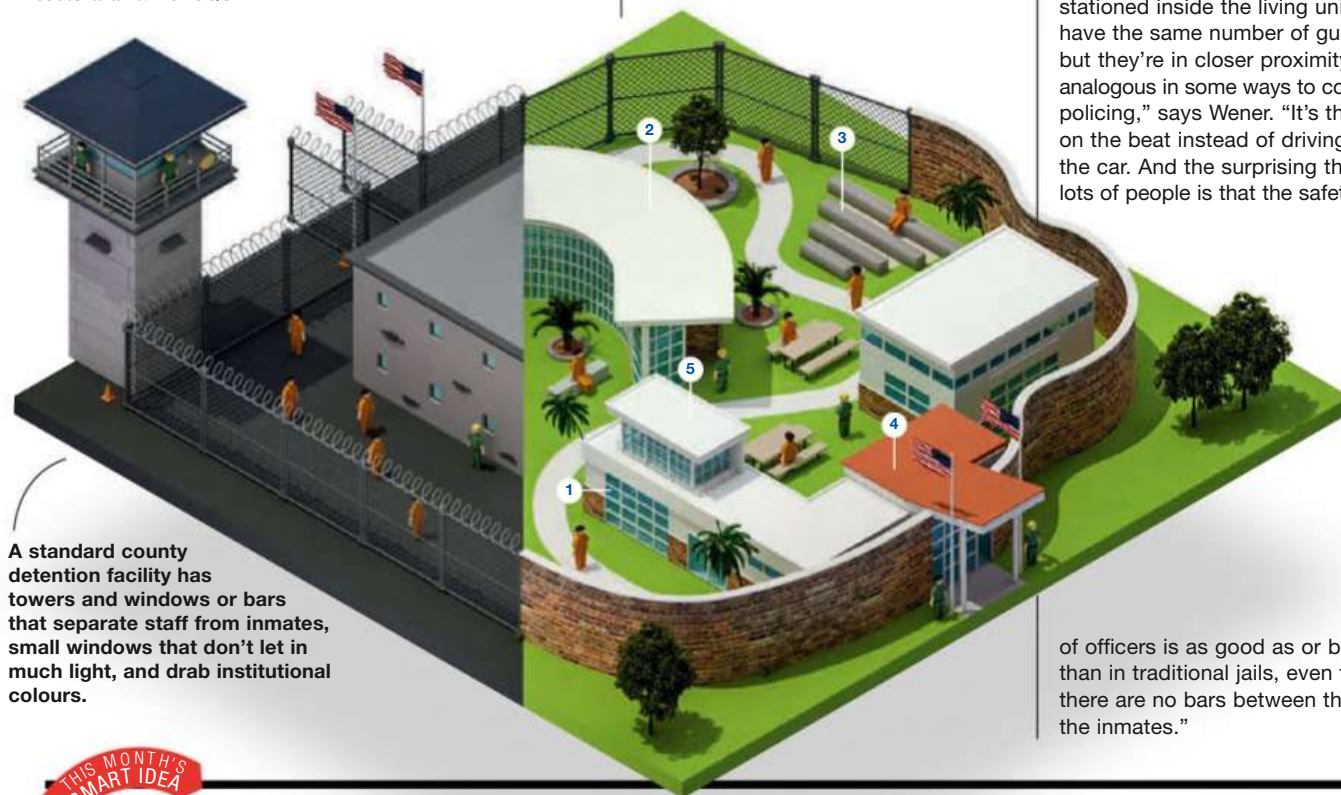
community of two-storey homes surrounded by outdoor areas, such as an amphitheatre. Inmates have personal space in the form of their own cubicles. The goal is not to make life fun, it's to reduce bad behaviour, which leads to extended stays and overcrowding. "Every time we go into a building, we read the environment, and it tells us what's expected of us," says Wener.

4. Open booking

Las Colinas' open booking area is more like a large doctor's office than the standard tank that prisoners are tossed into. "When you're in a mixed room, and you feel like there are a lot of dangerous people around and they're gonna assault you, you have only a few options, and none of them are good," says Wener. "In open booking, the worst thing that happens is prisoners get bored for a few hours."

5. Integrated guard areas

Instead of observing inmates through windows, Las Colinas deputies are stationed inside the living units. You have the same number of guards, but they're in closer proximity. "It's analogous in some ways to community policing," says Wener. "It's the cop on the beat instead of driving by in the car. And the surprising thing for lots of people is that the safety record



A standard county detention facility has towers and windows or bars that separate staff from inmates, small windows that don't let in much light, and drab institutional colours.

of officers is as good as or better than in traditional jails, even though there are no bars between them and the inmates."



Tablets for inmates One reason many inmates return to prison after release is that they aren't able to develop technology skills while serving their sentence. Jail Education Solutions is working to change that. The company's incentive-based learning platform, Edovo, uses tablets to provide therapy, classes and certifications to inmates. Like other educational apps, Edovo even offers rewards for completed programmes. If an inmate spends three hours on a prep course for a general education diploma, he might earn enough credits to watch *Avatar*. – CAMERON JOHNSON



GAINING LEVERAGE

You didn't realise that the wheelbarrow needed a rethink, but the results are surprising.

LIFTING 80 KILOGRAMS WITHOUT ANY STRAIN on the body is a sensation only the most accomplished strongmen know. But I did it on a sidewalk in Jo'burg, while trying to contain my laughter. The Amandla wheelbarrow is the hilariously effective brainchild of Jordan Gianno's relentless pursuit to improve the comfort of labourers. The science of moving the wheel to the centre converts the lever class from a Type 2 to a Type 4.

By moving the fulcrum closer, the weight is centralised over the axle, greatly reducing the required lifting force. Two bags of cement deep and I could already feel a big difference from the conventional wheelbarrow, but there was also one important drawback.

Placing the weight squarely over the wheel means that you need to account for the height of the wheel in the design. This brings the centre of gravity up quite significantly and then it becomes a bit of a balancing act. You also can't steer the wheel around a corner easily and rather then need to pivot yourself to align the wheelbarrow with the direction change.

Granted, Amandla is still in prototype form, but since the project is up for crowdfunding you'd expect those kinks to have been sorted out. I'm happy to back Jordan though, just to see how the final product will turn out. As it stands it will improve the longevity of many backs on building sites across the country, even though the mechanics are a bit jittery.

Contact Jordan on 011 024 0282 if you want to get involved.

A literal representation of the Amandla effect.



It looks strange when compared with the conventional layout.

THE DOCTOR WHO WOULD BE PRESIDENT

Taking a scalpel to a living brain requires a superhuman amount of confidence. Perhaps that's why Ben Carson, a retired neurosurgeon with no shortage of audacious opinions, believes he can win the Republican nomination and become the first medical doctor in the White House.

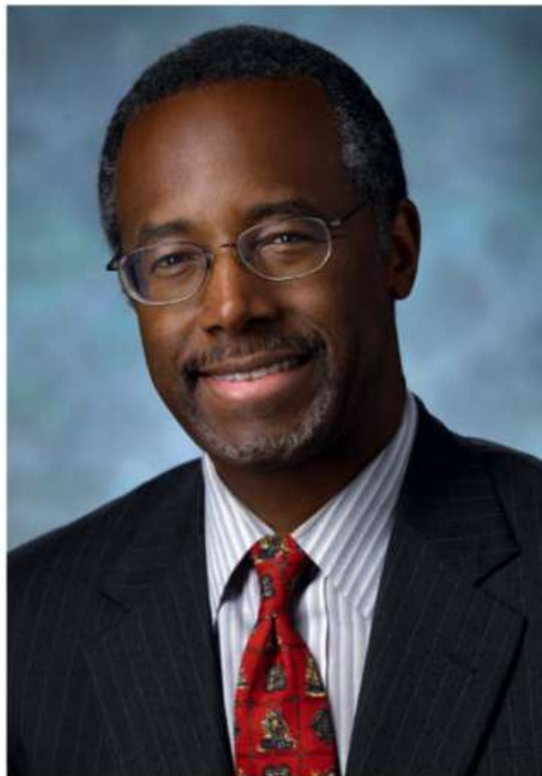
INTERVIEW BY MATT GOULET

POPULAR MECHANICS: To start, I have to ask the obvious question: How do you think being a surgeon would prepare you to be president of the United States?

BEN CARSON: The thing that has helped me is being faced with a lot of supposedly impossible situations – things that people said can't be done. What I would do in those situations is say, well, that's probably true. But maybe we could look at some other ways of doing it. I recognised early on that it's important to be able to bring in people with other perspectives. If you can amalgamate their energies and their intellect, you'll be much further ahead than if you're trying to come up with all the answers yourself.

PM: You've come up with a couple of right answers yourself, though. You convinced a bunch of doctors to give conjoined twins hypothermia to save them.

BC: The first set of conjoined twins I separated, I sat down with people and I said, if we use hypothermic arrest at the critical time in the operation, we could avoid having the patients bleed to death. I just talked about how exactly that would work. When people heard it, they agreed. It's a matter of being able to explain things in a way people can easily understand in order to gain their support. And I think the same is true when you're leading a nation. The



majority of people in our country don't understand what the fiscal gap is. You have to be able to explain that in a way that they get it.

PM: Do you have any strategies for dealing with the times when people don't get it?

BC: You always have to be in active mode, thinking about what works and what doesn't work. I've learnt that there's certain language that doesn't allow people to actually hear what you're saying because they're just concentrating on the words that you've said. I've learnt how to moderate that so I can get the message out without distracting people with the words.

PM: Does it frustrate you to hear people say that because a president can't decide

to become a surgeon tomorrow, someone like you shouldn't be able to decide to be president?

BC: It's frustrating in the sense that people who say things like that have very little understanding of what is required to be a neurosurgeon versus what is required to engage in the political sphere. They're two completely different skill sets. A lot of people want you to believe that you can only run things in government if you have detailed knowledge of all the nuts and bolts of everything. I completely disagree.

PM: When you retired from neurosurgery in 2013, where did you leave the field? What's going on now that's really cool?

BC: What's going to be extremely cool going forward is the integration of robotics into the whole process. Robots are much more precise than humans, no matter how good the humans are. They can magnify things so that vessels that are normally just a few millimetres apart look like

there's a mile between them. Robots are being integrated into urology and cardiothoracic surgery. The instruments aren't quite delicate and fine enough yet for neurosurgery. But they're coming.

PM: That's interesting coming from someone who titled his autobiography *Gifted Hands*. You're okay with ceding control to a robot?

BC: Somebody will still have to control the robot. And you will have to know what you're doing to control it. But, you know, it's progress. It's just like flying an airplane. People fly 747s, but they don't do much of the flying anymore. The computer does it. But they better know what the heck they're doing nonetheless.

HOW TO MAKE A US PRESIDENT

Ideally, in a democratic race, the people choose the candidate based mostly on his or her platform.

In real life, there are a few traits that winners have in common.



apollo

GO THE ————— DISTANCE



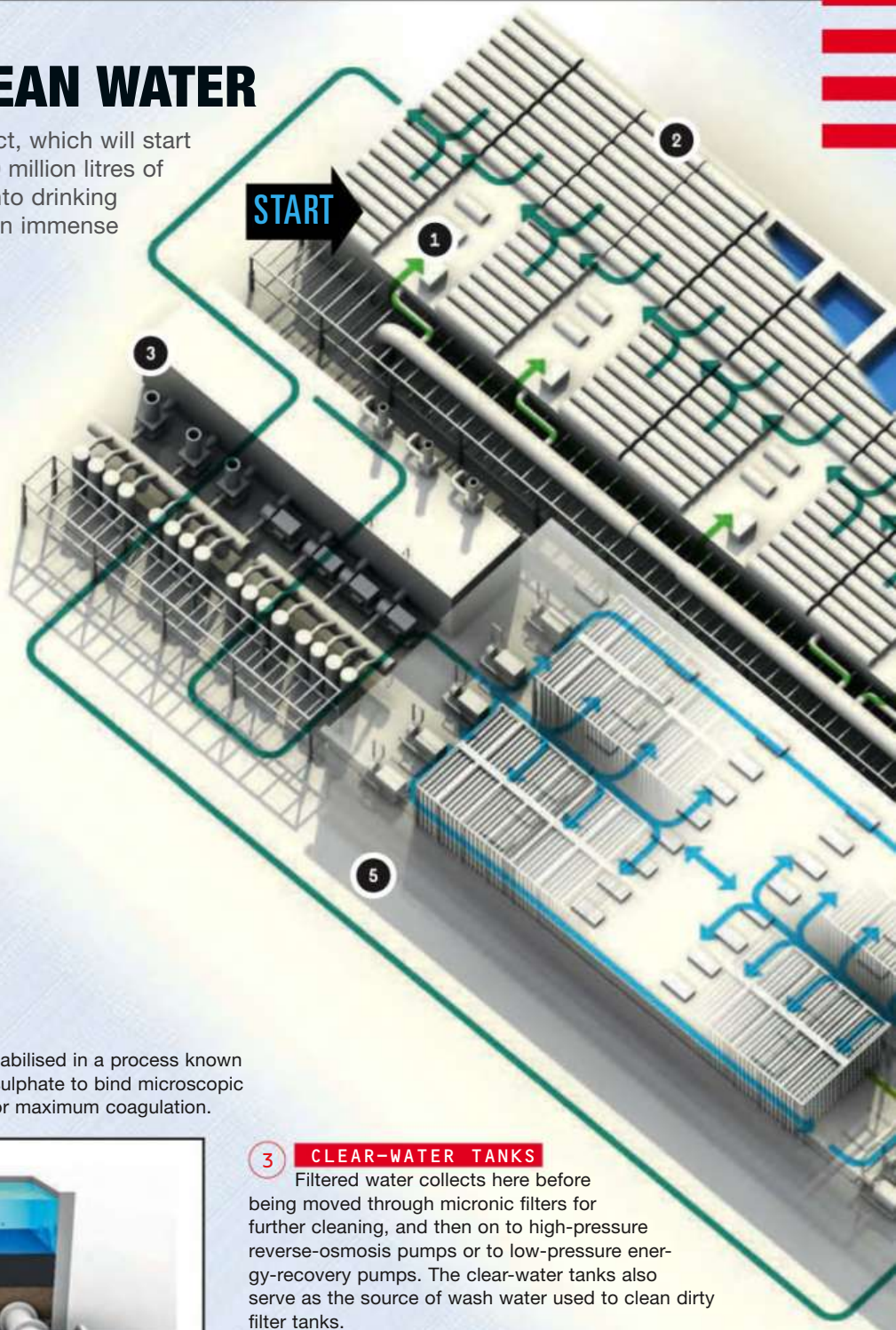
DESALINATING OCEAN WATER

California's Carlsbad Desalination Project, which will start operating later this year, will process 400 million litres of seawater daily, turning about half that into drinking water. Such a huge operation requires an immense amount of energy, so efficiency is key.

WHEN DEAN SPATZ BEGAN his introduction-to-engineering-design class in his second year at Dartmouth in 1963, reverse osmosis, the process of filtering water through a semipermeable membrane, was only four years old. Working with a team, Spatz used RO to create a prototype for turning undrinkable brackish water into a potable liquid. The commercial applications were obvious, and Spatz dedicated the rest of his time at Dartmouth to developing the nascent technology. After graduating, he founded Osmonics Inc, one of the first reverse-osmosis companies, in his garage in Minneapolis.

Today reverse osmosis is vital to a wide array of industries. "It's absolutely astounding that it's happened so quickly," Spatz says. By far its most common use is in desalination plants, which convert seawater into drinkable water. Later this year the 23 000-square-metre Carlsbad Desalination Project near San Diego, the biggest plant in the western hemisphere, will begin creating roughly 200 million litres of freshwater per day. At the heart of the plant is RO technology supplied by General Electric, which acquired Spatz's Osmonics for \$253 million (about R3 billion) in 2003 – just 40 years after he and his team developed their first prototype.

BY ANDREW DEL-COLLE



1 FLOCCULATION CHAMBERS

Before the seawater can be filtered, it's destabilised in a process known as flocculation, using a coagulant such as ferric sulphate to bind microscopic particles. In the chambers the water is agitated for maximum coagulation.

2



MULTIMEDIA FILTRATION TANKS

After flocculation, the seawater is moved to 18 multimedia filter tanks. Each tank is made of steel-reinforced concrete and contains 1-metre layers of anthracite and sand resting on a bed of gravel. Each layer filters out organic matter and particles before the water exits through a drain in the bottom of the tank.

3

CLEAR-WATER TANKS

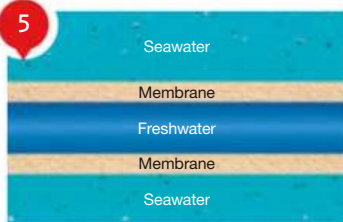
Filtered water collects here before being moved through micronic filters for further cleaning, and then on to high-pressure reverse-osmosis pumps or to low-pressure energy-recovery pumps. The clear-water tanks also serve as the source of wash water used to clean dirty filter tanks.

4

WASTE-SOLIDS-DISPOSAL BUILDING

The wash water used to clean the filtration tanks is run through lamella clarifiers (inclined plates that capture particles) and then on to centrifuges atop the disposal building to be separated into semiclean water and sludge. The water is recycled, while the sludge is turned into solid filter cake for truck removal.

5

**REVERSE-OSMOSIS SYSTEM**

This stage accounts for 85 per cent of the 10 kilowatt-hours per 4 000 litres the plant uses for desalination. Here, half of the clear water is pumped through 14 reverse-osmosis arrays at an elevated pressure of 800 pounds per square inch, forcing water through electrically charged membranes and thereby removing most of the salt. The brine left in the arrays – twice as salty as seawater – remains in the system at slightly less than 5 500 kPa. Rather than waste this pressure, the plant recaptures it to perform RO on the other half of clear water routed to the energy-recovery system. The remaining brine is discharged to the sea.

6

ENERGY-RECOVERY SYSTEM

By recycling the pressure used during RO, the energy-recovery system reduces the plant's total amount of power consumption by 30 per cent.

7

PERMEATE STORAGE TANK

This is where the majority of the permeate, or post-RO water, is temporarily held while 20 per cent is run through a second reverse-osmosis process, further reducing boron and bromide levels. This water is then blended back in with the rest of the permeate to meet water-quality standards.

8

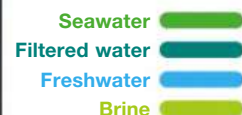
POST-TREATMENT PLANT

At this point the permeate has trace amounts of salt, but all hardness has been stripped out. To reharden the water and make it non-corrosive, a third of the permeate flows through calcite filters in the post-treatment plant to increase calcium and alkalinity levels. This water then rejoins the rest of the permeate.

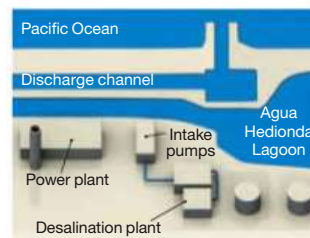
9

PRODUCT-WATER STORAGE TANKS

After chlorine, fluoride and ammonia are added, the permeate ends up in the final underground tank, which can hold 9 million litres of water. The stabilised and disinfected water sits for at least 45 minutes before being pumped into a 16-kilometre pipeline that eventually connects to the San Diego County Water Authority's regional aqueduct system.

WATER-FLOW STAGES**FINISH****INTAKE AND DISCHARGE CHANNELS**

Up to 1,1 billion litres of seawater per day will be pumped from intake channels connected to Carlsbad's Agua Hedionda Lagoon. The channels and the intake pumps were preexisting and are shared with a nearby power plant set to close in 2017. When that happens, a new intake pump will have to be built.





WHAT'S THE LIKELIHOOD

THAT INNOVATIONS IN ENERGY PRODUCTION AND VEHICLE EFFICIENCY HAVE BEEN QUASHED BY CORPORATIONS BEFORE SEEING THE LIGHT OF DAY?



What's the likelihood that a bear...

Actually, there are two levels to this one. There's the paranoid, urban-legend take that promulgates fantasies about the suppression of inventions like muscle cars that run on a thimbleful of water. Then there is reality, which acknowledges that big corporations are, by their nature, self-interested and not above a certain degree of, shall we say, chicanery when it comes to defending their competitive positions.

During the 1930s and '40s, a consortium of companies including General Motors, Firestone Tire, and Standard Oil bought up and shut down tram systems in a number of American cities in a bid to force public transit towards the use of petrol burning, tyre-using buses. GM and several others were convicted of conspiring to monopolise public transportation, but got off with paltry fines. More recently, attention has centred on GM's introduction – and abrupt withdrawal – of an electric car during the 1990s. The brief and smashing success of the EV1, as it was known, spurred research and production of electric and hybrid vehicles by others and arguably led to the advent of the Toyota Prius, so any impure impulse there may have, ahem, backfired.

Mostly, though, corporations defend their interests through good old-fashioned, completely legal palm-greas... er, lobbying, seeking to influence public-policy decisions in ways that favor their businesses and disadvantage others. As David Keith, professor of applied physics and public policy at Harvard, puts it, "Businesses don't require conspiracy, because their interests are clear. Everyone expects regular coal-fired generators to lobby against solar and wind power. And they do." Does this mean that certain promising, nascent technologies may be challenged or even strangled? Does a bear...



The cold water out of my bathroom tap is always much colder than the cold water out of my kitchen tap. Is this a common phenomenon?

It is indeed common for water temperature to vary from tap to tap within a home, and, yes, often water from a bathroom tap is colder than water drawn in the kitchen – which is why we suggest you cool your beer in the bathtub and bathe in the kitchen sink.

To understand this phenomenon, assume for the moment that your home is supplied by city water mains, which, insulated by virtue of the fact that they are underground, keep water pretty cold – around 12 degrees. Now consider the placement of the various taps in your home. Bathrooms, as the chief dispensers and consumers of water, tend to be located, by design, closest to where the water enters your home to cut down on costly interior plumbing. In short, a bathroom gets its water sooner, which means it's colder when it gets there, and it uses lots of water, which means the water doesn't sit around warming up in your home's toasty 20 degree pipes before it's used. A kitchen, meanwhile, is likely to be situated further away – so water has more of a chance to warm up on its journey to your tap – and generally uses less water, which means that when you turn on the tap

you're often getting water that's been hanging around indoors for a while. Note: if you draw your water from a well, or your pipes run through concrete slabs, none of this may hold true, so grab a nice cool drink from the toilet tank or the dishwasher inlet hose as the mood may strike you. It won't matter either way.

How did Apple settle on nine minutes as the snooze time for its alarm clock?

When you're Steve Jobs, you need only nine minutes, baby. That's how good he was. In nine minutes Jobs could redesign the iMac, invent 16 new, never-before-seen-on-Earth colours for your kid's iPod Touch, and dash off a complete schematic for the upcoming iToaster Air, which somehow would actually be thinner than a single slice of bread.

In truth, the nine-minute standard is one thing Apple didn't invent. It traces its roots to the very first snooze button, introduced by a General Electric subsidiary called Telechron in 1956. Basically they added a switch hooked up to the existing gears in the clock, which, due to the way they happened to mesh, made a more-intuitive-feeling, round-numbered ten-minute extension impossible. So nine minutes it was, and it just kind of stuck – a nostalgic nod to analogue quaintness in a shiny, precise digital age.

PM

Get it.
Love it.



Digital Door Locking



The world's favourite lock since 1843



The smarter way to protect your home.

GREAT STUFF

Samsung Wireless Audio 360

Well-rounded sound ▶

It's time to call off the search for the true room-filling wireless speaker because Samsung's latest offering includes Ring Radiator technology, which synthesises the different audio components and sends them all around the room. Furthering the 360-degree sound ambition is the use of compression drivers and an audio lens. The two models include the bass-heavy stay-at-home WAM7500 and the portable WAM6500.

They will connect to your Wi-Fi network or via bluetooth and integrate with Samsung's Multiroom App 2.0 (a centralised hub that can control a network of audio sources and speakers). Local pricing hasn't yet been established, but it will be available shortly and you can visit samsung.com for more information. From R3 000.





Leatherman Signal

Baby, you can light my fire ▶

The great outdoors makes its own special demands on multitools and that's why Leatherman has created its new Signal. In addition to the usual pliers, can opener, saw, awl and removable pocket clip, the Signal adds such vital survival tools as a ferrocerium fire starter and whistle. Plus, it includes popular features such as a hammer, replaceable wire cutters, diamond-coated file, and bit driver.

Price: R2 230. Find out more: www.leatherman.co.za



Garmin Edge 20 and 25

Pedal, connect, share ▲

Billed the world's smallest GPS cycling computers, the Edge 20 and Edge 25 both capture time, distance, speed, total ascent and location. Accessories (heart rate monitor, speed sensor and cadence sensor) hook up via ANT+ technology and, on the 25, you can use connected features to instantly share your workout on social media or with friends and family. Price: R2 340 (Edge 20) and R 2999 (Edge 25). Find out more at www.garmin.co.za

Canon ME20F-SH

Leave nothing unseen ▼

"Although it's now considerably after sunset, we observe in this rare full colour footage the extremely shy Lesser Spotted Crepuscular Whatsit, here seen for the first time in its natural habitat..." You don't have to be Sir David Attenborough to appreciate the giant leap in low-light performance made by Canon's new professional multi-purpose video camera. In conditions that would normally require infra-red supplementary lighting – resulting in black-and-white images – the ME20F-SH is able, unassisted, to capture Full HD colour video down to less than 0,0005 lux. Maximum ISO is in excess of 4 million (+75dB). It's all powered by a newly developed Full Frame 35 mm with 2,26 MP CMOS sensor and a DIGIC DV4 processor. Remote control and lens swapping are enabled. The overall package, both ridiculously tiny and professional-grade, is ideal for specialist applications such as night-time wildlife, deep sea/cave exploration, astronomy and surveillance.

Find out more at www.canon.co.za
Price: R400 000.



LG UF680 65-inch UHD TV

Brighter than the sun ▶

LG move the needle on LCD panels by combining the luminescent power of 600 candles per square metre (600 nits) with a full spectrum RGBW pixel arrangement. The so-called M+ technology present in this IPS (in-plane switching horizontally aligned pixels) panel achieves a 37 per cent reduction in power consumption over the standard RGB panel when set to the same brightness and the Korean company claims a wider range of colour reproduction with the addition of the white pixel. With a refresh rate of 200 Hz and a 4K-certifying 8,3 MP on screen, the ability to produce images at a rate of up to 60 frames per second seems almost secondary. While UHD still



lags behind proper cinema 4K, it's refreshing to see a TV panel pushing the colour boundaries, but the differences besides the power savings and 50 per cent increase in maximum brightness over the RGB model are barely visible to the naked eye when presented with a side by side test. Price: about R25 000. Contact lg.com/za



Motorola Moto G (3rd Generation)

Marvellous mid ranger ▼

The original cellphone maker was acquired by Google and subsequently sold off to Lenovo since it was last a player in the local market, but somewhere in that time they struck affordable gold. Moto X still represents the flagship for Motorola smartphone engineering, but the Moto G is by far the most important product for the company. There are two versions of the new Moto G, which differ only in on-board storage and RAM, so you want the 16 GB version with 2 GB RAM. Downside is that Orange (the only reliable Motorola retailer in SA) only carry the lesser 8 GB variant with 1 GB RAM. You'll still pocket a capable device running a largely untouched version of Android 5.1 Lollipop, equipped with the 13 MP rear camera that did excellent service in the Motorola-built Nexus 6 and a 5MP selfie camera. Processes are carried out by a quad core Snapdragon 410 chipset clocked at 1,4 GHz and the entire package is sealed in a water- and dust- resistant shell with an interchangeable back cover, expandable storage and topped with a 720p 5-inch display. Price: R2 900. Visit store.orange.com



Jawbone UP3

Your life, in detail ▼

Multi-sensor tech in this new Jawbone wristband tracks your lifestyle to provide a detailed biometric picture of your health and fitness. It captures heart rate, detailed sleep stages and workouts automatically. The advanced multi-sensor platform includes a new tri-axis accelerometer, sophisticated bio-impedance sensors, and

skin and ambient temperature sensors.

New smart algorithms allow the UP3 to automatically identify workouts and classify your activities, including running, cross-training, tennis, and more. Advanced Sleep features include detection of detailed sleep stages including REM, Light and Deep sleep. It's also future-proof, with the potential to capture more health data through future firmware updates.

You can join the dots with the Smart Coach app, which tracks your progress and gives you customised guidance – a kind of personal trainer on your wrist.

Battery life is up to 7 days and it's splashproof. Price: R2 399.





GREAT STUFF



Linksys RE6700 Wireless Range Extender

Make the circle bigger ▲

Those who use Wi-Fi-enabled mobile devices at home – and there are more and more of us – often fall foul of the first law of networks: your favourite spot in the house doesn't necessarily provide the best signal strength. The Linksys RE6700 eliminates dead zones by providing a signal boost up to more than 900 square metres, but adds a few tricks besides.

Like Linksys Spot Finder, which identifies the best reception areas. The RE6700 also features auto cross brand technology to optimise data relay – useful during streaming – and Beamforming to focus and strengthen the Wi-Fi signal. A 3,5mm audio jack allows direct speaker connection to stream music wirelessly and AC mains pass-through means that plugging in doesn't rob you of a socket. Price: R2 499. Find out more at www.linksys.com

Zagg Slimbook for iPad Air 2

Transforming productivity ▼

Although your laptop remains the most powerful tool to get work done, tablets have come a long way and are quite handy when needing some on-the-go productivity. Slimbook is a clever bluetooth keyboard with a hinged clip to hold your iPad in place so that it mimics a laptop. Since it comes with a compatible case, you can enjoy your iPad as the tablet Steve Jobs intended it to be, as well as having full protection and the ability to get some real work done on it. The hinge offers 135° of viewing angles, keys are backlit and the battery will last about a month with casual use.

Contact Gammatek on 011 201 0800 for product availability enquiries.



WD My Passport X

Gaming the system ▲

Storage device specialists have ignored the gaming community for far too long, so it's refreshing to see a market leader coming with a console-focused approach to file management. The 2TB My Passport X works with the Xbox One and PCs and holds capacity for around 50 titles so you don't need to blow your budget to get more on-board storage or have to delete purchased titles. USB 3.0 means you won't need external power and file transfers happen at blazing speeds.

Price: R1 999. Visit wdc.com for stockist details.

PM

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APPENDIX 12 MARINE CHART

POPULAR MECHANICS

Bob Ballard's

ENDLESS VOYAGE

BY

Ryan D'Agostino

Thirty years ago this month,
he discovered the wreck of the *Titanic*.

He could have stopped there.

And yet today, at seventy-three, he remains the
world's most vigorous ocean explorer.

An exclusive look on board his ship
and inside his world.

PHOTOGRAPHS BY BEN SKLAR

Robert Ballard is belowdecks on the R/V *Knorr*, an 85-metre research vessel owned by the Woods Hole Oceanographic Institution in Massachusetts, staring at a bank of screens. He wears a blue cap and a blue shirt and his face is lit by the humming blue glow of the monitors. At forty-three he has completed more than seventy expeditions as an oceanographic explorer and discovered sprawling geologic phenomena, entire species, whole undersea worlds no one knew existed. And now this. Thirteen thousand feet below him, *Argo*, an underwater search vehicle equipped with a video camera, has captured images of craters – craters that would be inexplicable outside the context of this expedition. Ballard has long been trying to find the wreck of the RMS *Titanic*. So many men have come looking for the unsinkable boat since it sank in 1912 that Ballard has a decent idea where the massive ship is not. Where it actually came to rest on the ocean floor is a much more difficult proposition. Not so much a needle in a haystack as a needle in a haystack at the bottom of the ocean. In his explorations he has found important vessels, and he will go on to find many more, any one of which would constitute a major find, the capstone of a career. But the *Titanic* is orders of magnitude different. The *Titanic* is the Holy Grail.

Of course, the truth is that the *Titanic* isn't even Ballard's real mission. This is not an Ahab situation, and Ballard is not on a quest. Earlier this year the United States Navy asked Ballard, who is a commander in the reserves, to assist in a secret mission to find two nuclear submarines that had been lost at sea for two decades – they needed to determine whether the subs were releasing radiation into the ocean. And they needed *Argo* to do it. The Navy told Ballard that if he used *Argo* to find the lost subs, and if he had any time left over before the *Knorr* had to get back to port, they would secretly finance his search for the *Titanic*.

He found the subs, and now here he is in the control room, and images of these impressions on the ocean floor have Ballard wide awake. More than seven decades after the ship's catastrophic collision with an iceberg, could it be that these craters were left by some of its shattered remains?

Argo's camera, the explorer's powerful unblinking eye, closes in. And what it picks up next will alter the course of Bob Ballard's life.

Ballard stands on the stern of his ship, the *Nautilus*, waiting. At seventy-three he stands over six feet tall, he's trim, and his skin is tanned and tight after more than five decades spent mostly at sea. The sun is shining in Galveston this morning, and a breeze drifts across the deck. He's waiting for a group of donors, some of the many financial backers who help make possible his adventures. After a few minutes, an SUV pulls into the vast grey parking lot on the pier next to the ship. A group of Houstonians wearing pressed golf shirts and flowery sundresses has arrived to meet the famous explorer and to get a tour of his ship, and Ballard bounds down the gangway to greet them with smiles and big handshakes all around. He bends at the waist to greet a little girl and ask her name. He leads the group aboard, showing them the way with a large upturned palm and holding the hands of the ladies as they climb from the pier to the deck, gestures he has performed hundreds of times for hundreds of his supporters.

As always he wears his *Nautilus* uniform, the same outfit every crew member on board is issued: navy-blue polo shirt with a gold compass insignia. Underneath it reads E/V *Nautilus*. Not R/V, because *Nautilus* is not a research vessel. Research vessels set out to prove hypotheses, which, if you ask Bob Ballard, can be a little redundant. You're proving something you already pretty much know. No, the *Nautilus* is an exploration vessel, like it says on the shirts: E/V.

He wears a matching navy-blue cap. No name, no rank. All the blue polo shirts and caps are the same. The point is, everybody on the *Nautilus* is important. Fifty-five per cent of his staff (his "corps") are women – a Ballard mandate – and an even higher percentage are students at some stage of their undergraduate or graduate studies in oceanography, geology, biology, archaeology, engineering or filmmaking. ("You don't have to pay 'em," he says of the students.) You get to issue mandates when you are president of the trust that you created and that owns the ship, as Ballard is. The Ocean Exploration Trust. His trust. His ship. His responsibility.

Money is a frequent topic of conversation for Ballard, because it takes R130 million annually to keep the *Nautilus* in the water for four to six months every year. (Similar vessels, he says, cost six times that.) Ballard's unique position as an oceanographer/owner makes him both liberated and beholden. For that money that frees him to explore, Ballard must regularly court private donors, corporate sponsors and politicians who believe in his mission enough to fight for public dollars. The donors love to hear about the *Titanic*. The politicians are guided by an interest in everything from Ballard's commitment to education to his exploration of the earth's crust.

These days, empirical findings have become the slings and arrows in some very nasty and subjective debates. And the scientific method, which has been the wellspring for so much of America's greatness, now seems to be turning the country against itself. In this atmosphere, Bob Ballard and his relentless quest to master the ocean bottom have, improbably, become the basis for a broad political consensus. Rep. John Culberson, a Republican from Houston and chair of the House Appropriations subcommittee on commerce, justice and science, has won millions of dollars of financial backing for the Ocean Exploration Programme run by NOAA, the National Oceanic and Atmospheric Administration, which supports Ballard's trust. The congressman is intensely interested in Ballard's work discovering natural resources in

**"Man to Mars? Ridiculous.
We've explored less than
10 per cent of the ocean floor.
So in my final years I said, 'Let's
create a ship of exploration that just
goes. Because we haven't been.'"**



the nation's exclusive economic zone (EEZ), a collar of ocean floor along US coastlines to which it owns exploration rights. "Dr Ballard's the first scientist I'm aware of that's made a concerted effort to map the EEZ and catalogue the mineral resources there," he says. "China's cleaning our clock in locking up 97 per cent of the world's rare-earth elements, controlling vital resources, and positioning itself to become the superpower of the 21st and 22nd centuries. So Dr Ballard is an easy sell to my colleagues, Republican and Democrat."

After Ballard finishes the tour for the wealthy Houstonians – nice folks, good time – he is sitting in his quarters, a sparse wood-panelled room above deck with a bunk, a desk and two framed illustrations from his favourite book, *20 000 Leagues Under the Sea*, on the walls. His phone buzzes with an incoming email. He fastens his glasses, the kind that snap apart at the bridge, and scrolls down.

"Oohhhh, wow. Yes! Yes! God bless him. The House has already... now the Senate... Yes!"

It's an email from a contact in Washington. Ballard and his team have been waiting to hear about a major funding request from Culberson's committee, and the chairman has come through.

"Yes! I just have to sit here for a minute."

He drums his fingers on the table, his mind racing. Claps a few claps into the air.

"That is absolutely huge. Oh, *man*. Culberson gets it."

Titanic brought him fame and a little fortune and the promise of a career as long as he wanted one. He wrote a cover story for *National Geographic*, where he was an explorer in residence. And yet it was a discovery of a known thing. Ballard seems prouder of his discoveries of the prizes for which he was not looking – the prizes you win, he says, by spending "time on the bottom". In 1977, he discovered the very existence of hydrothermal vents, hot springs in the ocean floor near where tectonic plates move apart from one another, releasing a steady flow of superheated water from deep in the Earth's crust. The water is a chaotic mess of mineral-rich fluids including sulphide that, when discharged into the frigid, pressurised water on the ocean floor, can create new ecosystems hospitable to a wild mix of creatures. In the worlds of marine biology and geology, it was a monumental discovery. In the actual world, nobody much noticed.

He discovered the wreck of the German battleship *Bismarck*, too. In 1989, in the North Atlantic. He discovered the wreck of PT-109, JFK's World War II boat, in 2002. The naval ships sunk at Guadalcanal. He was first to explore the *Lusitania*. But the *Titanic* is what keeps the people showing up. The *Titanic* is why yesterday three hundred local schoolchildren flocked to the *Nautilus* to meet Ballard and to run around his ship.

"When I found hydrothermal vents, no kid wrote me a letter," he says. "The *Titanic* was my seventieth expedition. But when I got back from the *Titanic*, I couldn't see my desk. The mail that came in – they poured it on my desk while I was still at sea. I said, what is this? They said, *it's kids*. And they were all saying the same thing: What do I have to do to do what you do?"

Ballard thought a lot about those letters. Thought about what he could do with this knowledge that there were children out there who wanted to be a famous explorer, which he suddenly was. He was forty-three. Born in Kansas into a hard-living family ("My grandfather was shot in a gunfight")

and raised middle class in California, he had become a respected oceanographer and a commander in the Navy. He had clawed through the publish-or-perish tenure process in academia and earned job security at the University of Rhode Island. But now he was the man who had found the *Titanic*, and he would be for the rest of his life and well after his death. He didn't have to give lectures or co-author papers. He did, however, want to teach.

The letters from children gave him an idea: with the right technology, maybe he could teach from the sea.

Not just any oceanographer gets to have his own ship. *Nautilus* is a 61-metre former East German research vessel, built in 1967, that Ballard has so far spent R195 million reconditioning and outfitting as an exploration vessel. It carries seventeen crew and thirty-one scientists and operations specialists. On the ship's stern sits a winch the size of a Volkswagen that is used for raising and lowering Ballard's two remotely operated vehicles (ROV), Hercules and Argus, between the ship and the ocean floor – the winches can release more than forty-eight hundred metres of steel cable into the sea. Belowdecks, he has installed remote command centres throughout the ship – small, darkened rooms with a jumble of screens on the walls that constitute the nervous system of this whole operation, allowing Ballard and his crew to show the world what the ocean floor looks like. Mankind has only ever seen less than 10 per cent of the ocean floor, which is not very much at all, if you ask Bob Ballard.

Ballard is usually on board for one month a year. The rest of the time, he is tethered to the *Nautilus* by technology from his home in Connecticut or his office in Rhode Island. He has many more expeditions behind him than in front of him, and that creates a tense urgency in a man. Especially a man who appreciates the coefficient of his mortality, and knows by now that his ambition will outpace his life by a hundredfold, which is a startling discovery all its own. But to watch him aboard his ship is to witness a man possessed by the possibility of what he might find tomorrow. At this particular moment he is standing on the deck of the *Nautilus* in Galveston, 8:00 am, the sun trying to burn through a morning haze. In three weeks his ship will steam south through the Gulf of Mexico, through the Panama Canal, and down to the Galapagos Islands, where Ballard will revisit the site of the hydrothermal vents and "black smokers" he and his team discovered in 1977.



These claws are Ballard's hands when exploring the depths of the ocean.

"You can't discover unless you're exploring. It's time. What are you looking at? A whole lotta nothing. Turn the corner. Boom! We never knew

there were black smokers at 650 Fahrenheit coming out – till we turned the corner," he says. "It's all about being there so you can get lucky. And you have to do it as cheaply as possible."

It's hard to imagine that Magellan ever had occasion to say *Boom!* Harder still to imagine Columbus squiring Isabella aboard the *Santa Maria* to show how her money was being spent. But with every molecule of dry land now surveilled from space, this is how Ballard describes how the *Nautilus* is set up to handle the boom moments that come with discovering all that remains to be discovered in the three-dimensional chess of the oceans deep:

"It's like an emergency room. What's going to come in on an ambulance to the ER at two in the morning? You have no idea. So, how are you going to deal with that uncertainty? Well, you have some people there to do triage and keep the person alive. But then what do you do when you need a specific expert? You have doctors on call, and you call the right one for the situation: 'Get in here.' That's how we run this ship. When we find something, we call the right expert."

Ballard has assembled, over the years, an astonishing roster of experts in many fields, all volunteers. When the *Nautilus* is at sea, towing its cameras through the depths, and it finds something interesting, the crew needs to know whether to stop and explore further or move on. And they can't keep fifty experts on board at all times. So the *Nautilus* has a phone system with a 401 area code. "The ship thinks it's in Rhode Island at all times, no matter where on the planet it is," Ballard says. "When we need an expert, we just



ROBERT BALLARD, DISCOVERER

DATE OF BIRTH: 30 June 1942

HOMETOWN: Born in Wichita, Kansas, grew up in Southern California

CHILDHOOD HERO: Captain Nemo

CURRENT HERO: Captain Nemo

PLACE OF BUSINESS (ON LAND): The University of Rhode Island Department of Ocean Engineering, where he is professor of oceanography and director of the Centre for

Ocean Exploration

PLACE OF BUSINESS (AT SEA): E/V *Nautilus*

PREVIOUS EMPLOYER: US Navy for 30 years, rising to the rank of commander

UNDERSEA EXPEDITIONS: 140

THE ONE YOU'VE HEARD OF: His 1985 discovery of the RMS *Titanic* 400 miles off the coast of Newfoundland

BUT THAT'S NOT HIS FAVOURITE. HIS FAVOURITE WAS:

Uncovering hydrothermal vents

and "black smokers" in the Galapagos Rift and East Pacific Rise in 1977 and 1979; his findings helped scientists learn how life forms use the energy of the earth through chemosynthesis

MOST RECENT HONOR: Inducted as a Fellow of the American Academy of Arts and Sciences

OTHER FELLOWS: Thomas Jefferson, Albert Einstein, John James Audubon, Alexander Graham Bell

pick up the phone. It goes like this: 'Hi, Deb? I know it's 2:00 a.m. on Sunday morning, but can you boot up your laptop? *We got something.*

We wanna know what it is.

The ship is hovering in twenty thousand feet of water wondering, up or down?' And we do this literally all the time. All. The. Time. Within twenty minutes we have to deliver the brightest mind in America on whatever subject it is to the spot of the discovery to tell us what to do. If you tell us *go*, we go into a response strategy," Ballard says, jutting his chin into the breeze.

"It's an unbelievable feeling. The closest thing to a drug for me is Coke Zero. I don't drink coffee, I don't smoke. I do have wine. But you can't beat the thrill of finding something on the bottom. And I'll wait and wait and wait for it. We just had one on the last trip!"

That one went like this:

"We're down in the Lesser Antilles, in Grenada. A volcano called Kick'em Jenny is down here. Two plates going at it. It's the only active underwater volcano along the Lesser Antilles. We're looking at it, and we have this brand-new sonar on the ship that can make a mazing maps – R40 million mapping sonar, because you need maps. We can go to any place on the planet and make digitised maps of the ocean floor.

"We noticed that Kick'em Jenny collapsed in itself and set off a big avalanche. Okay, big deal. Volcanologist says, 'Okay, but I wanna go down to the bottom of the avalanche and pick up some rocks'. Fine. Well, it's the last day of the season, we had done everything we wanted to do. We told the *National Geographic* film crew to leave. We were doing a show, they had been with us for four months, but we told them we were just gonna go down and pick up some rocks. What do you expect to be down at the base of an undersea landslide? Rocks. But! *Surprise*. We head down the hill and we come across this river coming out of the side of the avalanche. What is this? *It's a river*. I know it's a river, dummy, but how do you make a river in an avalanche at the bottom of the ocean? And it's funny-coloured. And it's pretty violent. We ran up to the command centre.

"It starts off acting like an avalanche. But then – what's that? I dunno. Never seen an avalanche leak. It's like someone took a knife and cut across it. We're seeing all these shells and black stuff... an entire community of life here! It's chemosynthesising" – chemosynthesis being the process of microorganisms creating energy brought about by chemical reactions rather than the sun, as in photosynthesis. "Worms, brittle stars. This is at five thousand feet. I'm feeling very stupid right now. Gigantic mussels. Fourteen inches! Weird parasites living in them, bleeding blood, ghastly – like *Tron*!"

"We said, *Whaaa?* Working hypothesis: We're off the Orinoco, which is the Mississippi of South America. Full of

GALLO IMAGES/GETTY IMAGES/EMORY KRISOF



GREATSTOCK/CORBIS



Clockwise from top right:
The "black smokers" discovered in the Galapagos; navigating on the *Knorr* in search of *Titanic*, 1985; Ballard (in hat) on the nuclear submarine *NR-1* searching for geothermal vents near Iceland for *National Geographic*, 1985.



organics. And the avalanche squashed it and squeezed out methane – we *think* – and they're using chemosynthesis to process the methane into energy. Well, we had about a thousand scientists on the phone in twenty minutes. And they all said, go down! No one had ever seen this. How many avalanches are there in the ocean? Lots. But no one had ever gone down the bottom of an avalanche to *see*. So how many of these things have we missed? *Lots*. It's like Christopher Columbus coming back with this thing and saying, 'We're calling this a pine cone.' Well, how many do you think there are? *Lots*."

It was a major discovery.

Ballard steps back, leans on the gunwale of his ship, shaking his head just a little in amazement. His eyes are wide open. Behind them, his mind is somewhere else. His mind is five thousand feet under the Atlantic Ocean, off the mouth of the Orinoco River.

"You can't beat that."

Time on the bottom.

Long ago, long before even the *Nautilus*, Ballard had figured out how to teach from the sea. In 1989, he launched the JASON project, an ocean-centric educational initiative that has reached more than fifteen million American schoolchildren. (*JASON Jr* was the submersible vehicle Ballard piloted to explore the *Titanic* itself in 1986.) At the centre of his vision is an experience known as telepresence, which uses a mash of technologies to create a hyperreal version of virtual reality, in which a person has the sensation that he or she is on the bottom of the ocean – or in a rain forest or a desert, or on Madison Avenue – when

in fact the environment is being re-created around him using high-definition projection and sound capture.

James Cameron, who first met Ballard in the late 1980s at Woods Hole and whose path would cross Ballard's again when he directed *Titanic* the movie in 1997 – he calls Ballard “a dynamo” – felt the sensation while exploring the famous wreck, sending remote-controlled cameras inside the ship while he sat inside the Mir submersible. “After several hours inside a small, nimble vehicle, you form a kind of cognitive loop with that vehicle,” Cameron says. “You begin to interpret the image you’re seeing on the video camera as if it’s sensory input of a different nature. You start to get this kind of synesthesia effect, where interpreting the visual image starts to become kind of bodily, sensory input. Your consciousness now seems to reside inside the vehicle, and I remember a very curious sensation. I turned the [remote camera] vehicle to look back at the Mir submersible. I was sitting inside the Mir submersible at the time, but I thought, ‘oh, there’s the Mir submersible over there, far away from where I am’ – and yet I was physically in the Mir submersible! My mind had so seamlessly transplanted itself into the remote vehicle that I now thought of myself as being outside the Mir submersible looking back at it. That’s how profound the telepresence experience can be.”

Nautilus is equipped with telepresence technology, but because most classrooms are not, Ballard delivers to students what he can using the capabilities they have in common. Last year crew members aboard the *Nautilus* broadcast five hundred live dispatches – Ballard calls them “shows” – to classrooms, museums and science centres via interactive streaming video, so students can ask questions and get answers on the spot. Producers at the Inner Space Centre at URI’s Centre for Ocean Exploration and Archaeological Oceanography add video and graphics as the crew talks. The students witness the discoveries, and the trust uses the curriculum – which is free to schools – to attract sponsors who make it possible.

“People don’t care about the oceans, really,” Ballard says, sitting in his office back at URI, the waters of Narragansett Bay shining out the windows. “This is all about motivating kids to study harder. America is a star-based system. We worship individualism. I’m a star because I found the *Titanic*. Not because I found hydrothermal vents. So okay, go with it. I don’t sell kids and parents on the ocean. I sell them being a star.”

Every day he’s home, around five o’clock Ballard and his wife, Barbara, sit outside and watch the sun set over the Connecticut River. Bob fixes something as an hors d’oeuvre, Barbara pours them each a glass of wine, and they talk about the day. They eat dinner together every night, with their two children too, when the kids aren’t at board-

ing school or college. This family time is essential. Ballard’s father is dead (“He was an orphan”), and his mother (“God bless her”) is ninety-eight and lives in California, where she cares for Bob’s disabled sister, who is sixty-eight. His brother died of Crohn’s disease a few years ago. A son from a previous marriage was killed in a car accident, a devastating loss that Ballard can’t really talk about. Family is important to Ballard, because he doesn’t have much.

And yet there are times, after dinner or early in the morning, when Barbara knows her husband’s mind is someplace else. She knows his mind is at sea. He can call up his ship’s live video stream on its website, nautiluslive.org, any time, even on his phone – anyone can – and instantly he is on board, in the command center, staring at the ocean floor.

“You’re not here, are you?” she’ll say to him. And he’ll just smile.

He works in fifteen-year bursts of creativity. Fifteen-year projects, he calls them. He is seven years into *Nautilus*. And he already knows what he wants to do next. “That’ll be my last one,” he says. But whatever the project, he is determined to see as much of the ocean floor as he can before he dies. “I got addicted to it. In my fifty-five years of exploring, how much of the ocean floor have I seen?” He holds his thumb and forefinger close together. “In all my discoveries, just that much.” His eyes grow wide. “So how much have I not seen?”

Back in Galveston, he is standing in the ship’s stern, opening a can of Coke Zero, an unfinished one at his feet. “Jeez, I’ve got one here I haven’t even finished yet. It’s like a smoker who lights a new cigarette with the one that’s still burning.”

He sits down in the pilot seat of Hercules, his tanned, weather-beaten hands resting on the robot’s massive, shiny claws, not talking, an unusual motionless moment for him on this boat. The Port of Galveston is perfectly quiet. On the channel, a tern is challenging a pelican for the morning catch.

“My grandmother had all these sayings,” he says quietly. “And when I was raising my kids, they started to come out. They’ve asked me to start writing them down, so I’m doing that.”

He is studying the tern as it antagonises the much larger bird, which seems unperturbed. Their dance is the only movement along the harbourside.

“Never get into the thick of thin things,” he says. “I love that.” He smiles and stares down at the grey water, conjuring other pieces of wisdom.

“Great is the person who plants a tree knowing he will never sit in its shade.” He looks up, nods a quick nod, his eyebrows raised. “That’s education. That’s the long haul.”

It’s time to go. Galveston is an accommodating way station for the *Nautilus*, but Ballard’s team is waiting to go over the plan for the rest of the expedition. Fifty-five years in, the new world below the depths still awaits.

PM

SOME SHIPS BOB BALLARD FOUND



Bismarck

Sunk May 27, 1941
Found June 8, 1989



Titanic

Sunk April 15, 1912
Found September 1, 1985



USS Yorktown

Sunk June 7, 1942
Found May 19, 1998



JFK's PT-109

Sunk August 2, 1943
Found May 2002

THE TECHNOLOGY

Then and now

Robert Ballard's current research vessel, E/V *Nautilus*, was built in 1967, which actually makes it a year older than R/V *Knorr*, the ship he used to find the *Titanic* in 1985. How does that work? Ballard retrofitted the *Nautilus* with upgrades that help him better explore the depths. Here are a few of the differences thirty years of technological advancements make.

BY CAMERON JOHNSON

1985



► **Flag**
United States

► **Sailing range**
12 000 nautical miles

► **Length**
75 m, in 1985 (85 after renovations)

► **Lifting capability**
Equipped with a trawl and portable utility cranes

THE SHIPS

TODAY



► **Flag**
St Vincent and the Grenadines

► **Sailing range**
13 000 nautical miles

► **Length**
61 m

► **Lifting capability**
Equipped with a knuckle-boom crane

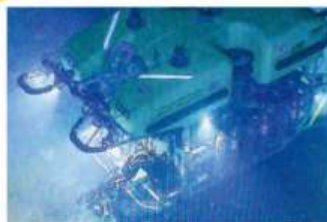
REMOTELY OPERATED VEHICLES

► **Ballard's two ROVs**, Argus and Argo, followed a debris trail to the wreck. They reached depths of 20 000 feet, but with limited piloting capability. Argo provided live video and Argus had three 35-mm colour cameras. But the cables connecting the ROVs to the *Knorr* used copper wiring, which is a poor transmitter and made

for bad image quality. And Argus used film that had to be developed.



► **Like their predecessors**, the ROVs Argus and Hercules provide live video and



photos. Both carry high-definition video cameras linked to fibre-optic cables, instantly providing sharp images to the researchers. The crew on board can navigate Hercules with a device called a Doppler Velocity Log that tracks its underwater location, allowing for greater control of the vehicle.

SONAR

► **Readouts for side-scan sonar** were recorded on special printer paper that the crew had to manually annotate with co-ordinates and time stamps. Then, in a process known as mosaicking, the team cut and manually pieced together the readouts with

scissors and tape to get a full image of the seafloor.



► **Sonar upgrades** mean that programs can instantly provide high-resolution visuals. And mounted on the *Nautilus*'s hull is a multi-beam echo sounder that allows the ship to create a 3D map of the seafloor up to depths of about 23 000 feet.

ON-BOARD SCIENTISTS

► **When Ballard** was searching for the *Titanic*, he was limited in assistance to the 26 other scientists who could fit on board the *Knorr*.

► **Ship-to-shore technology** – a satellite-based telecommunication connection that's just a little slower than high-speed Internet – allows researchers around the world to

tap into a live feed of the mission and offer assistance, meaning better and faster analysis. Schoolchildren can watch too – and feel inspired to become explorers.

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TESTED

GARMIN nüviCam LMT

See how you go

- ✓ Value for money, connectivity, voice control, safety features
- ✗ Some inconsistency in alerts

JUST A FEW YEARS AGO,

for the kind of money Garmin are asking for the nüviCam LMT, we'd have been quite satisfied with a personal navigation device that accurately routed us where we needed to go. Throw in a massive touch screen and Bluetooth and we'd have considered it a good deal.

That you can now get all of this plus a dashcam, voice control, apps and the level of driver alerts usually found on high-end cars, is kind of amazing.

The nüviCam is a breeze to set up for anyone with even a basic knowledge of PNDs. It's easily clipped in or out of its magnetic windscreen mount though the dash area can get a little cluttered with a power cable and a mic cable plus two additional suckers to consider.

The integrated camera swivels, allowing you to position the windscreen mount where you like and still get a good field of vision thanks to a wide viewing angle. The camera continuously records, automatically saves files to the included SD card on impact and can take stills, too. Visuals – high quality, even in poor lighting – can be played back on the device itself or on a PC.

Here's where it gets interesting. The camera also acts as the input for Forward Collision Warning and Lane Departure Warning. The system is designed for motorway travel above 65 km/h and the display shows when it's active. Visual and audio alerts warn you that you're too close to the vehicle ahead or veering out of your lane. Just bear in mind that when threading your way through motorway traffic the bells, whistles and ding-dongs can become a bit hectic. You can reduce the audio volume or mute it altogether if necessary.

In general I found the lane warning to be quite accurate, but the forward collision warning seemed inconsistent, not necessarily always picking up the vehicle ahead. Of course, unlike those upmarket systems, the Garmin doesn't actually brake your car automatically...



JUST THE FACTS

DISPLAY	15 cm touch screen
STORAGE	4 GB
PRICE	R4 999
Garmin.com/nuvi	

One thing I really liked was the voice control. No button push needed: just say, "Voice command" to activate the menu. It's a pity it couldn't be used to activate the apps as well.

Speaking of which, the app selection shows just how far PNDs have come in only a few years. There's the option of dedicated traffic information piped to you via a tracking device, but Smartphone Link, a free mobile app, can also provide real-time data services such as Garmin Traffic, updated every minute. An Eco app provides the kind of comprehensive guide to more fuel-efficient driving that would have been unthinkable – outside of a premium car – until recently.

On the navigation side, the nüviCam's smart features and connectivity help create feature-rich navigating. Up Ahead indicates services from restaurants to filling stations; Garmin Real Directions uses real-world landmarks as aids to directions; and at junctions PhotoReal and Bird's Eye views give a realistic picture of what is actually ahead of you. Foursquare data with thousands of new points of interest is preloaded. And, as you approach a destination, there's a neat trick: Garmin's Real Vision automatically switches over to camera view overlaid with an arrow pointing to where you need to go.

Incidentally, paired with the Garmin BC 30 wireless reversing camera, sold separately, the nüviCam is also able to provide a rear view.

– ANTHONY DOMAN



FLIR ONE

Burning up

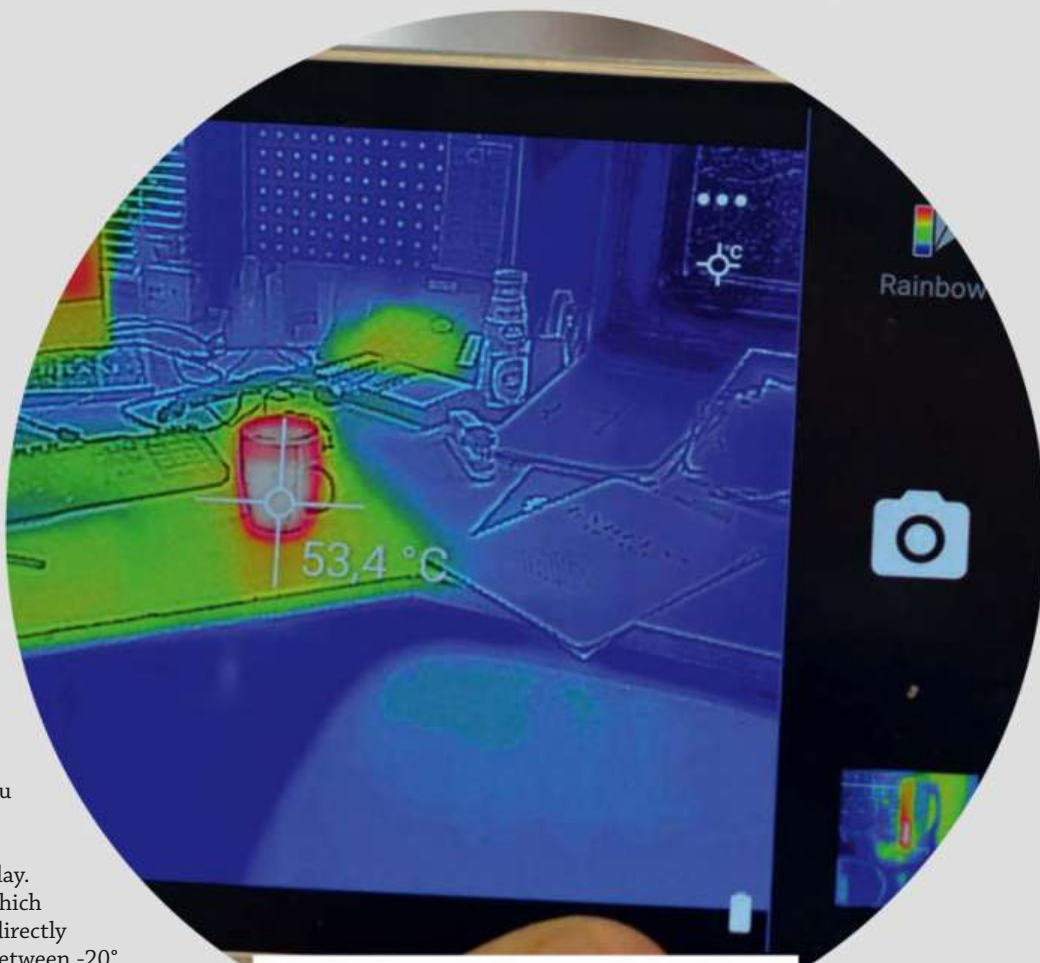
There's a place in the world for thermal imaging. Imagine not having to use a torch to check why the dogs are barking, or if you could reliably locate a rat in the ceiling without having to climb a ladder. I did both those things on my smartphone with the help of the Flir One module and companion app. Well, luckily I got a Huawei test unit in so I could use the Flir, because it plugs directly into the micro USB charging port and I wasn't willing to rip the cover flap from my Galaxy S5 daily driver to accommodate it.

How do you unlock the thermal imaging powers? You get a Flir One unit, which combines a normal camera sensor and thermal sensor, then download the free app on your phone. After that you just follow instructions.

The resolution isn't the best, but it does look amazing on the phone display. You can also measure temperature (which will need you to place the crosshairs directly over the spot you want to measure) between -20° and 120° C. It's pretty accurate, even at range, but the image does lag a little, so please don't expect it to work accurately while you're chasing after the would-be thieves just like they do in Hollywood.

It's a lot of money to spend on a novelty, but much cheaper than anything else out there if it's a real need in your life. — LINDSEY SCHUTTERS

PM



JUST THE FACTS

OPERATING TEMPERATURE	0° - 35° C
READING TEMPERATURE	-20° - 120° C
WEIGHT	30g
BATTERY CAPACITY	350 mAh (approximately 45 min operating time)
PLATFORM	Android and iOS
PRICE	R3 675
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THE LONELINESS OF THE **LONG-DISTANCE** RACING DRIVER

WHEN THE RACE ITSELF IS NOT
ENOUGH OF A CHALLENGE

BY ANTHONY DOMAN

CRAIG HARPER'S TYPE 5B

CONSTRUCTION	Glass fibre on steel spaceframe
ENGINE	Toyota, four-cylinder transverse
SUSPENSION	inboard rocker front, McPherson strut rear
BRAKES	Toyota

A crisp midwinter Thursday morning. At Harper Sports Cars, tucked away in an anonymous industrial zone in the Cape Peninsula's Deep South, the race weekend prep is done and dusted. Craig Harper levers his lanky frame into his open-topped race car. As usual, he will be driving the car to the track. His drive will take him through the Karoo and on to the 90-minute endurance event at Phakisa Freeway in Welkom. And back. Call it 2 500 kilometres.

Africa Endurance Series Whatsapp Group
Thursday 2 July
12.29 pm
Tanks full. Leaving Kommetjie now!

After several years of building and racing his own Harper Type 5 in Cape Town, Harper decided to do something different. His goal: to complete the African Endurance Series. Including driving to and from the race circuit. Five of the six events are out of Cape Town, with a round trip of up to 3 000 kilometres in prospect. It all comes to a head at the Nine-Hour at Kyalami on 21 November.

Initial results were promising, with two good finishes and two DNFs in the first four events.

But first, there was the little matter of Phakisa.

Africa Endurance Series Whatsapp Group
Friday 3 July
11.25 am
The car was very loose in P1. Upped rear tyre pressures and will try again in P2. Semis and no downforce. 2 min dead.

I'm looking up at Craig Harper on his workshop floor amid the pre-trip bustle. Up, because he's tall and I'm not. "The reason for the Harper Type 5 is the feeling that race cars are wasted because you can't use them on the road, enjoy them on the road."

The Durban boy who had relocated to Bulawayo aged two, created the Harper Type 1 as an 18-year-old apprentice. "It was a real hodge-podge of bits and pieces. I was given a beach buggy body and bought a VW Kombi King Cab as an unfinished project. "It already had a BMW two-litre engine plucked on to the back of the gearbox."

He drove it for a while, then – convinced he was a brilliant driver – sold it while keeping the bits he needed to build a racing car. The car itself? "Awful."

**Africa Endurance Series
 Whatsapp Group**
 Friday 3 July

2.45 pm
 P3 done. 1.56 is as fast as I
 can go on semis. We'll put the
 wing on now and see what she
 feels like in P4. It's all a bit siiiii-
 ideways on these old semis.
 4.33 pm
 Session 4 full aero best time
 1m55.2. Tomorrow we try the
 stickies.

The Harper is cast in the same
 mould as the Lotus Seven,
 which was Colin Chapman's
 attempt to give the Ford
 Anglia new life. "This Type 5 is
 an attempt to give a Toyota
 Corolla or a Celica or whatever
 new life. All the mechanicals
 are basically off the shelf." So
 it's a Corolla engine and gear-
 box at the back. "Pretty much how the Toyota MR2 did it years
 back, and the Fiat X1-9. I'm a mid-engined enthusiast. It's a
 different way of driving. Definitely more demanding."

Type 1 had a BMW mid-mounted engine in the back, a VW
 Beetle gearbox ("not the best choice in the world"), and swing arm
 suspension. Once over that phase, he built some Super Seven rep-
 licas. "Out of a *Car* magazine... or was it *Scope*? There was a picture
 of a blue Lotus Seven. So I measured the wheels, figured out that
 they were 15s, measured the wheelbase. I could get the kit in
 Bulawayo, funnily enough."

His personal Seven was a proper, very quick, race car. "It held
 several lap records, in fact probably still holds the records to this
 day because they've changed the classes!"

Africa Endurance Series Whatsapp Group:
 Race day, 4 July
 3.46 pm
 18th doing 1m56s

"The whole point of driving it to all these races is to encourage
 fellowship among all the sports car users. I'd love to see a series
 where, within a race day or the race weekend, there's a class for
 all the guys who drive there and back. That would be awesome.
 With lights and registration plates and seats in, road tyres and
 you've got to take a picture when you leave home and when you
 return. That would be a dream come true."

The endurance thing, where did that come from?

"Look, the car's not the quickest," says Harper. "It's competing
 against proper bespoke racing cars. But I believe that if you're
 there at the end in the longer races you're in with a shout. It's all
 about that business of getting a rhythm going."

Africa Endurance Series Whatsapp Group:
 Race day, 4 July
 4.18 pm Consistency for Index.
 19th overall at 15 min in and still holding 1m56s

"And of course it's a good test of a car. You know, you can do a
 drag that lasts a few seconds. Then you don't have to have a cool-
 ing system. If you've got a creeping temperature problem, in a
 ten-lapper you can deal with it. In an hour, two, six – or nine
 hours, that's our goal at the end of the year – it's a real test."



**Craig Harper ponders
 last-minute prep for his
 drive up to Phakisa. Left,
 "pit crew" Mike Jay
 loads up the wagon with
 the tyres that will do
 duty on race day.**

His favourite bit is when it gets dark. "I especially love racing
 into the night. Obviously sunset is a bit of a mission when you
 come around some of those corners, but I absolutely love it."

He digs in the memory banks to recall teenage days in the dark
 trackside at the Bulawayo circuit. "The Lola Chev would be thun-
 dering past, and it's dark – there were no lights – and you'd see
 a flashing light and think, oh that's Bruce Glasby. Bruce is my
 mentor, a fabulous mechanic."

"That sort of emotion of racing into the night is really special."

He's remained with moderate power. "I've said, guys, we can all
 race together. We can race with the Sevens. We can be competitive.
 If you are running various engines, it's very difficult to group
 them together."

If you want more power there's the Type 6, which has got the
 engine north-south. "That's meant for a V8, with an Audi box
 behind it. It's a much heavier car and obviously has the potential
 for much more power. Funnily enough the weight distribution is
 very similar between the Type 5 and the Type 6, about 60/40."

Out in the wild, 15 customer Type 5s are already running
 around.

"It's been seven years," he says. "But this year there's a lot more
 interest. People are talking about the attempt we are making on
 the series. They seem to enjoy it. This is something that your middle-
 aged man, like me, can relate to. He's got a long-held dream,
 wants to build a car... these guys with a bit of spare cash, changed
 circumstances. But I've got younger guys as well. Ninety per cent
 of them race and most do in fact use them on the road."

In competition, the Harpers put in a decent showing. "In a
 35-car field, we run about 10th to 12th. It's quite respectable. In



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built Sevens so I know what it was about. That was it, boom boom boom.”

All he wanted was a car for some fun on the salt pans, with room for two. “And I wanted to do l-o-o-ng donuts.”

Africa Endurance Series Whatsapp Group

Race day, 4 July

6.45 pm

Lauren Muller's engine extracted from her 7 ready to be transplanted.

6.56 pm

Nice people, these 7 owners.

“And then I thought, you know what, I might just build a car out of this. And then the real work started. Putting a chassis together was no problem, but the shape... I was in Botswana, with no access to anything: seats, high density poly foam. So I went to my local

hardware store and bought some chipboard and plywood. I read somewhere that if you soaked the stuff in water it would bend and then take that set. I would just do that, and go and put them somewhere in a ditch with some bricks and they sort of took a bit of a set.

“The whole thing was built out of wood. Suddenly I was a carpenter. There was dust everywhere for months. It turned out more or less like the current shape, inspired a bit by the Porsche Spyder look with the pointy front.”

He didn't like it.

“But after I'd made it, I said, well, it's too late now. And we made a body out of glass fibre. It was the first time for me – I didn't know what I was doing. Now we are vacuum bagging, so we've come a long way. Now we are going to try resin infusion and then we are going to try carbon epoxy layups.”

Africa Endurance Series Whatsapp Group

Sunday 5 July

10 am

Spares, oil, etc bought at 07h30 in Midas. Love the Free State shope opens 7 days a week 7 to 7.

1.21 pm

All together!!

In between building cars on commission Harper fixes up racers, homebuilt Sevens and the like, with a staff of half a dozen drawn from Masiphumulele, the nearby informal settlement. His “pit crew” is Mike Jay, who met via his involvement with Caterham Sevens, of which he owns three. Together, they've driven more than 10 000 kilometres. With many more to come.

“Because I'm a mechanic and mechanically minded, I love the challenge of finding what the car can give me, sustainably,” Harper says. “Not burning the brakes out or frying the tyres...”

Africa Endurance Series Whatsapp Group

Monday 6 July

5.20 pm

Home!

PM



The Harper Type 5 uses off-the-shelf mechanicals: Toyota engine, gearbox and running gear.



the first six-hour, we finished fifth overall. We beat Le Mans prototype cars.”

Not bad for a car that began life on a Botswana workshop floor.

Africa Endurance Series Whatsapp Group

Race day, 4 July

4.18 pm

Dropped a valve. Out

“I was in Botswana for about five years. I started a new business there in suspension – suspension's my thing. I had a specialist workshop and we would go out the pans on our land yachts. Sailing on the dry salt pans. Awesome fun.”

There was other stuff, too. “A buddy had one of these cheap Chinese things, a buggy with a roll cage. He was doing donuts and I began thinking, maybe I should build one of those things.”

For a few pula, Harper bought a Toyota Corolla that had been wrapped around a tree and salvaged the important bits.

“Then I sat on the floor with some chalk, drew the layout, with the engine architecture, basically around my dimensions. I had

■ Part 8 of our series Motorsport Technology Down the Ages

A winning strategy

*As the hare and the tortoise proved, the fastest is not always the winner.
That's why the right strategy is critical*

Speed isn't everything. The ability to use that speed to best advantage, on the day, ultimately decides the winner. What it comes down to is choosing a good strategy that will achieve the desired result.

What determines modern-day race strategy? Essentially, two main factors:

- Tyres
- Track and grid position.

Aside from the track and grid position, the major influences on strategy have had one important thing in common – the pit stop, which has thus become central to Formula One strategy.

To outsiders, it may seem strange that races can be won and lost in the pits. For one thing, pit stops are optional. Nevertheless, teams spend hours honing their pit-stop skills, creating an almost balletic quality in their efforts to shave thousandths of a second off their benchmark times.

For a time, fuel efficiency played a decisive role in this spectacle. Obviously, the weight of the fuel in the tank affects the car's performance and handling, some greater than others. And, of course, there's also the engine's fuel economy while racing to consider. Until 2009, cars were able to be refuelled during pit stops. But the potential danger – and some spectacular incidents – resulted in a rule change to ban refuelling from 2010.

As a result, tyres have come to dominate the action. In racing, tyres should be soft for best grip, yet robust for extended life. Formula One racers use identical rubber from a single supplier,

in different specifications for dry weather. In wet conditions, super-soft tyres with massive grip are needed.

Analysis over time allows teams and manufacturers to calculate precisely when a tyre's performance is at the optimum. However, when conditions are changeable, a combination of skill, knowledge and intuition is called for when a decision has to be made: dry, wet or intermediate tyres?

Regarding the influence of the track, some circuits have plenty of places to overtake, but others (such as Monaco) have far fewer overtaking opportunities. Expert drivers and their teams work out, in advance, a strategy for overtaking. They may find that the best place to "overtake" is by implementing an expertly timed and executed pit stop.

The final piece of the jigsaw is driver skill. Many have the ability to extract the maximum performance out of a car on a given day, but few are capable at the same time of balancing that with keeping it running optimally, nursing it to the finish line. Similarly, tyre management isn't just about chemical composition and physical characteristics: the driver's skills and style can influence tyre wear, as can the track layout.

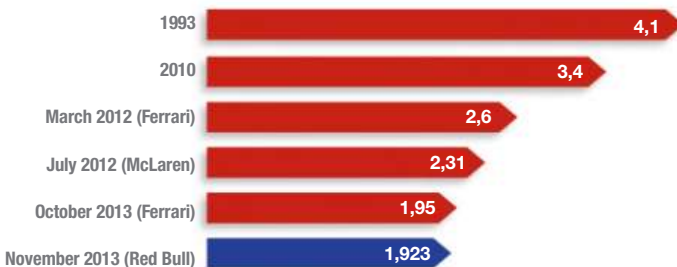
Even in today's high-tech racing world, then, there's still room for the human element.

Full wet tyres have deep rain-displacing grooves and soft compound.

Formula One pit stop WORLD RECORD

Evolution 1993-present

At the 2013 US Grand Prix, the Red Bull team completed a pit stop – four tyres changed – for Mark Webber in 1,923 seconds. That is stopped time, of course: the total time taken for a pit stop includes slowing down, stopping, tyre-changing and accelerating back up to speed. That can take half a minute.



“TO A GREAT FINISH”

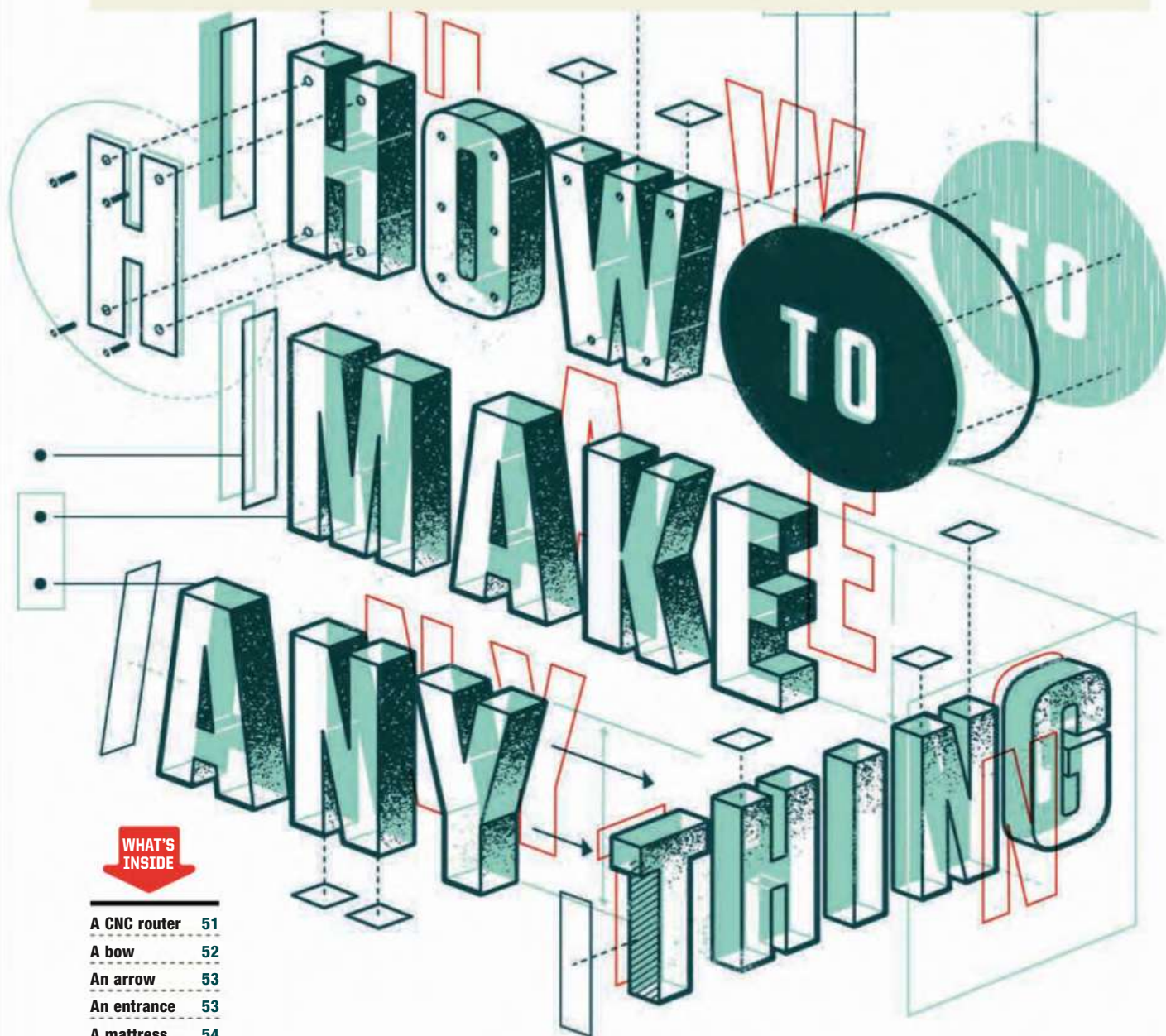


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Before you finish reading the next 10 pages, you will want to build something. Maybe it'll be one of the ideas in this issue. A smoker made out of an old wine barrel. A backyard table with a cooler built right in, saving all those seconds you used to waste walking to the Coleman. A new way to charge your cellphone while you're riding a motorcycle or cooking dinner. Or maybe it's something else. It doesn't matter to us. In this, our second annual guide to making anything (or at least anything we can think of), our goal remains the same. We want to inspire you. We want to tap into that innate desire to create. We want to get you to do something that humans have been doing ever since we got these opposable thumbs. And we want to make backyard drinking even easier, one cooler-table at a time.

HOW TO MAKE

A CNC router

Ehad Bridgewater makes great new things out of great old things. A blue-collar metalworker from St Francis, Wisconsin, with an artistic disposition, he transforms classic cast-off tools into modern shop gear. His CNC router (right) began life as a 1946 Delta drill press, which he rescued from a trash heap outside a machine shop in Milwaukee, where it was manufactured. The basic process of each machine isn't that different, just reversed. A drill press uses a movable drill to puncture a stationary object. A CNC router uses computer-controlled stepper motors to move an object as it's cut by a stationary tool. Bridgewater walked us through some of the foundering, boring, foam cutting and 3D printing it took to update this 69-year-old machine for 21st-century use.



— KEVIN DUPZYK

The rails, belts and pulleys were pilfered from a ten-year-old Stratasys Prodigy Plus 3D printer. Bridgewater bored them to fit the press with his own World War II-era lathe.

The brains of the router are a decade-old computer Bridgewater poached from a previous employer when it upgraded its hardware.

Bridgewater made the cast-iron bed mount himself. He used a CNC router to cut a foam pattern before switching to traditional techniques, turning the pattern into a sand mould that was filled with molten iron.

The bed of the router is scrap acrylic from laser cutting, purchased from a local plastics company.

The black plastic bearing housings that allow the bed to move were prototyped on a homemade 3D printer and finalised on a MakerBot 2X. Three skateboard bearings in each housing help the bed move smoothly along the rails.

Like the drill press, the post and stand are original Delta parts, from an online find.

The electronics are housed in an Allen-Bradley enclosure, saved from an exhaust hood scrapped during a building renovation.

PHOTOGRAPH BY TOM FRITSCH



A
STEAM-FREE
MIRROR

1. Before a shower, spray a dollop of cheap shaving cream on your bathroom mirror.
2. Wipe it off with a paper towel.
3. Admire your work, and yourself.

A bow

HOW TO MAKE

It starts with the right tree.

After a compound bow failed him on a turkey hunt more than a decade ago, 29-year-old Michael Spink of Spink Wooden Bows in Pocahontas, Arkansas, started making his own wooden bows by hand. He walked us through the process of crafting a 175-cm Native American longbow.

— ANDREW DEL-COLLE

1 FIND YOUR TREE.

Avoid weaker woods such as pine and willow in favour of hickory, oak and maple. Look for a diameter of at least 200 mm, which will require less carving. (Because bows are made from vertical slices of the tree, on a smaller tree the arc of the outside edge – the part that becomes the back of your bow – will be more pronounced, requiring more shaving to flatten it out.)

2 CUT AND SPLIT THE TREE.

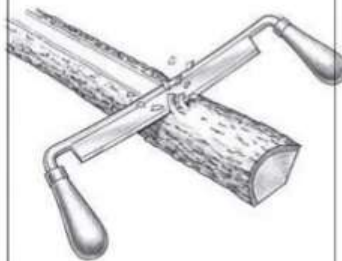
A 200-mm tree provides six or seven bow staves. Leave enough room on the end of each stave to cut off roughly 150 mm, where the wood might have cracks. (For example, a 175-cm bow needs at least a 2-metre piece of wood.) Keep the stave roughly 45 mm wide from tip to tip and 25 mm thick. Leave the bark on to reduce cracking as the wood dries.

3 LET THE WOOD DRY.

This typically takes at least three or four weeks but can be up to a year. (If you want to be sure, buy a moisture meter and wait for a read-out of 11 or 12 per cent.) The most flexible wood will warp into a bend called a reflex.

4 DEBARK YOUR BOW WITH A DRAWKNIFE

(BELOW) AND MARK THE SHAPE OF THE BOW'S BROADSIDE. For a Native



American longbow, the 125 mm in the centre should be narrower than the limbs – 30 mm across, widening out to about 40 mm. About 475 mm from the midpoint, taper down the limb to end with 12 mm-wide tips (A).

5 WITH A DRAWKNIFE OR BAND SAW, REFINE THE SHAPE. Use a pocket-knife to finish things off.

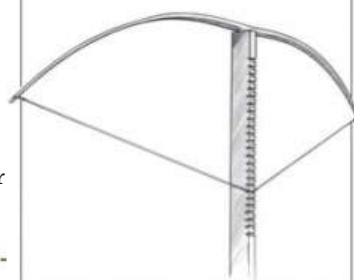
6 LAY THE BOW FLAT AND TAPER THE SIDES OF THE LIMBS WITH A DRAWKNIFE. The middle 125 mm, which will be your grip, should be 20 mm thick, tapering off to 12 mm when you reach the ends (B).

7 USE A CHAINSAW FILE TO MAKE STRING GROOVES AT A 45-DEGREE ANGLE ON THE OUTSIDE OF BOTH TIPS, ABOUT 12 MM FROM EACH END.

On the bottom limb, make an extra set of grooves for the bow stringer, a separate string used to bend the bow for stringing.

8 SAND DOWN THE EDGES AND TIPS AND

SMOOTH THE FRONT AND BACK SURFACES. Then, with one tip of the bow against the ground, apply pressure to the top to create a slight bend – this is called floor tillering – inspecting the bow for any cracks or imperfections. If you see anything other than small cracks on the front, you'll have to start over with a new piece of wood.



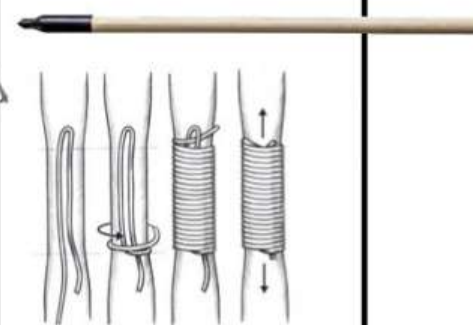
9 CREATE A TILLER TREE (ABOVE) TO TEST YOUR BOW'S FLEXIBILITY.

Vertically secure a 50 x 100 plank to the wall. Starting 125 mm from the top, make a horizontal notch with a Skilsaw every 25 mm until you reach 750 mm. String the bow loosely with parachute cord, centre it on the top of the tree, and slowly move the string down the notches until it reaches the 710-mm mark, a typical full draw. At each step look for unevenness in the bend of the limbs. If they don't bend equally, even them up by shaving from the side that doesn't bend as much.

10 SHORTEN THE PARACHUTE CORD TO MAKE A SMALL BEND IN THE BOW (125 MM BETWEEN THE BOW CENTRE AND THE STRING).

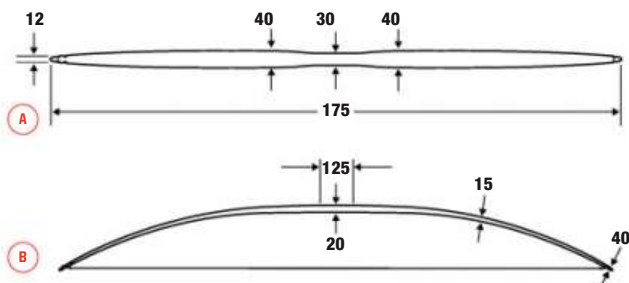
Repeatedly draw the bow in a mirror to see which side remains slightly stiffer. The stiffer limb will be your lower limb. Once you identify it, use a sander to create a shallow indentation above the handle to the right or left, depending on which hand you use to shoot, for the arrow.

11 SAND AND FINISH THE BOW. Hunters may want to use a dark stain because it's harder for animals to see.



12 ONCE THE BOW HAS BEEN STAINED, DRIED, AND SEALED, WRAP THE 125 MM OF HANDLE WITH HEMP CORD USING A WHIPPING TECHNIQUE (ABOVE). Apply a light coat of glue, such as Titebond III, and let dry.

13 CREATE YOUR FINAL BOWSTRING USING A NEW LENGTH OF B-50 BOWSTRING MATERIAL. A properly strung longbow should have enough bend to leave roughly 175 mm between the bow and the string.

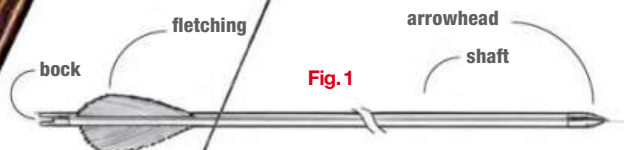


Once you master the longbow, this more complicated pyramid-style bow is waiting for you.



AN ENTRANCE

1. Wait for a new song or a long silence.
2. Throw open the door. Double doors are good. Saloon doors are ideal.
3. Smile. Scan the room and point towards anyone making eye contact.



HOW TO MAKE

An arrow

It makes the bow a lot more fun.

Although you can cut your own shafts, you don't want to. It's too complicated, and even the smallest imprecision can throw off your shot. Which means making your own arrows is really more of a process of assembly than of construction.

— LARA SOROKANICH



Paul Jalon of Elite Arrows in Bloomfield Hills, Michigan, has crafted his own arrows since 1952. They've been used to win 24 International Bowhunting Organisation World Championships.

1 Shaft diameter is determined by the weight of your bow and other factors. Consult a spine chart, such as the one on *3rivers-archery.com*, to find the appropriate diameter, then order a set of matched wooden shafts (about R400 to R600 for a dozen). Jalon prefers to use cedar, but Sitka spruce and oregon pine work, too. You'll also need nocks (about R125 per dozen; size is based on shaft diameter), a fletching jig (R450 to R1 100), a taper tool (less than R125); size based on shaft diameter), and archery feathers (about R200 per dozen). (See fig. 1) Turkey feathers are the industry standard because of their thickness and consistency.

2 Wipe the shafts down with acetone to remove any sap, then lightly sand them.

3 Use the taper tool, which resembles an oversized pencil sharpener, to taper one end of the shaft to fit your nock. (Taper tools make both 5- and 11-degree tapers. Use the 11-degree one for the nock.)

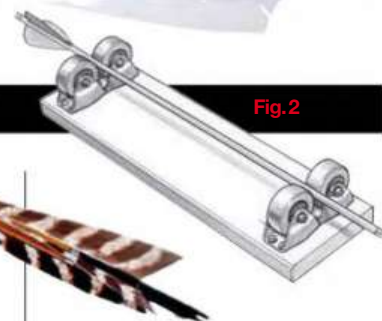
4 Roll the shaft in an arrow spinner to find any bends. (You can build a simple version yourself using four castors. See fig. 2) Treat any curves by holding the arrow firmly on a flat surface and running the body of a screwdriver over it from end to end. This should force the wood to lie flat. Repeat until the shaft looks straight in the spinner. This is the most important step, so

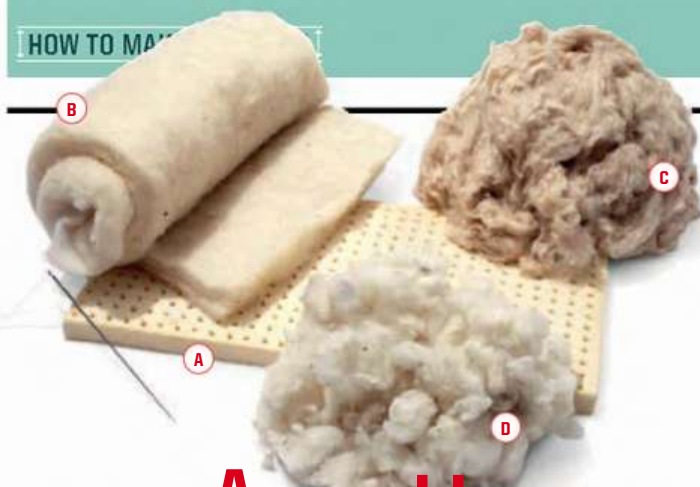
be sure to get it right before moving on.

5 Seal your shafts by brushing them with acrylic floor finish. Let them dry for three to four hours, then sand lightly. Repeat for three total coats.

6 Use clear fletching cement or instant glue to attach a nock to the tapered end of the shaft. Then use a fletching jig (Google it) to attach three or four pre-cut feathers, and let dry.

7 Place the uncut arrow on your bow and draw it back. Have someone else mark the arrow an inch in front of the bow handle. Cut the arrow at the mark, taper the cut end, and apply your point or broadhead using hot glue or epoxy. Let dry.





HOW TO MAKE

A mattress

Many commercial mattresses contain fire-retardant chemicals, which is useful if you're ever in a fire. But throughout the life of the mattress, those chemicals are gradually released into the air in a process called off-gassing, so the rest of the time they're actually a bad thing. Especially for kids.

Making a mattress is actually quite easy. Just buy a premade ticking, or cover, and stuff it with two filling layers – one for support, one for comfort – zip it up, shake it to help settle and align the contents, and lie down. The only real decision is the filling. Deborah Brenton of *diynaturalbedding.com*, which stocks all of these materials, including the ticking, explains.

A. NATURAL LATEX

The most common choice as a bottom support layer. You'll need anywhere from 75 to 175 mm depending on your weight. For a softer mattress, use three 75-mm layers. Hard at the bottom, medium in the middle, and soft on top.

B. WOOL TOPPER

A good comfort layer if you sleep on your back or your stomach and thus tend towards slightly firmer beds. You will need 4,5 kilograms of wool to fill a queen.

C. KAPOK FIBRE

This fluff-like material comes from seed pods. It's far more commonly used in India, and would be an exotic choice for a firm sleeping surface. You'll need about 28 kilograms for a queen-sized bed.

D. WOOL FLAKE

A tough, dense material that self-regulates temperature. Makes a firm to hard bed. Twenty-two kilograms provides 150 millimetres of cushioning in a queen. (You'll want to tuft it to the ticking to avoid bunching. Brush up on your sewing skills.)

HOW TO MAKE

A forest

Johnny Appleseed had his little satchel, determination and patience for long walks. Lauren Fletcher has a drone.

Whether it's from clear-cutting or wild-fires, hundreds of thousands of square kilometres of forests are lost every year. Regardless of the billions spent, it's hard to keep up. But Lauren Fletcher, a former

NASA engineer and the founder of BioCarbon Engineering, has a plan – and a device – that might help. This year his company announced a drone that will plant at a rate of ten trees per minute. That's 12 times as fast as human planters. A group of eight drones can plant a total of 36 000 trees in one day in practically any terrain.

The first step is finding a place in need of a forest. BioCarbon works with local governments, coal and oil companies, and local ecologists. Once a suitable location has been determined, the company uses satellite mapping programs and its own mapping drones to create a detailed 3D map of the area. Then the planting drones are sent in. Each device holds 500 biodegradable seed-pod cartridges, which it fires using pressurised air, lodging each one 7 to 12 centimetres in the soil. Upon impact, the cartridge breaks open and the seed is planted. Lab tests have shown a 70 to 80 per cent chance of survival.

Fletcher plans on planting his first forest by the end of the year in Brazil or South Africa, and by 2020, he hopes to plant one billion trees per year. Even that isn't enough to completely counter deforestation, but it will provide plenty of clean air, animal habitats and tyre swings.

– CAMERON JOHNSON

A USB CHARGER FOR A MOTORCYCLE

You can add a USB charger to almost anything with electronics – your alarm clock, coffee machine, fridge, or aquarium. Since I'm a motorcycle guy, I installed one on my bike, but these instructions are adaptable to pretty much anything

with a power supply. Just be sure to unplug whatever it is before you start tinkering.

– NIAL MCGAUGHEY

1 PURCHASE THE RIGHT USB CHARGER. You want a USB port with electronics that limit output to 5 volts so you don't fry your device.

2 ROUTE THE WIRING. The charger needs to be wired

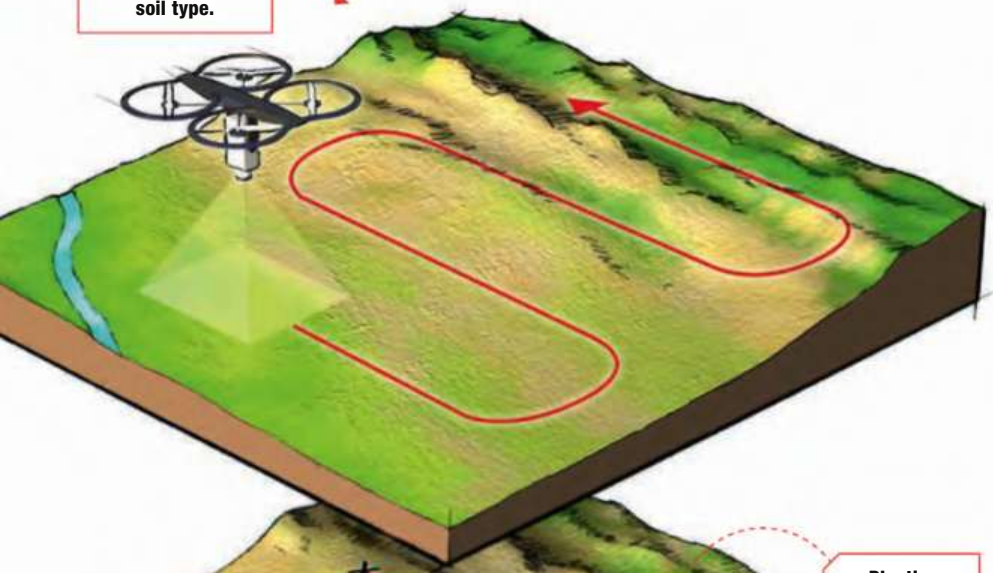
to the power source with a fuse in between (**fig. 1**). On an appliance, you're looking for a 12-volt line to tap into – something that leads to a lightbulb, like the one in an oven or fridge, is a safe bet. On my motorcycle I wired to the battery and used a standard automotive fuse. Choose the right one by taking the current (in milliamps) required by your device (about 900 mA for most cellphones) and multiplying it by 1,5.



Nial McGaughey
runs Hovercraft
Amps in
Portland,
Oregon.

PHOTOGRAPH BY BEN GOLDSTEIN

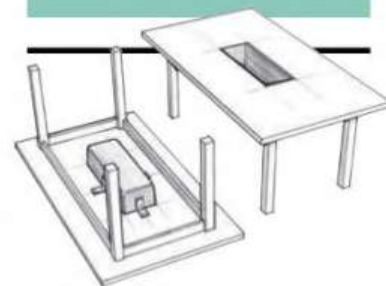
A mapping drone creates an optimised planting pattern based on topography and soil type.



Each drone can plant for up to 50 minutes, after which it returns to the launch site to have its batteries replaced and seed canisters refilled.

Planting drones move at less than 1 km/h and fly 2 to 3 metres off the ground. Every metre a biodegradable cartridge is fired into the soil.

Biodegradable cartridges hold pregerminated seeds covered in a nutrient-rich hydrogel to help absorb moisture as the seed establishes itself in the soil.



HOW TO MAKE

A table with a built-in cooler

You can improve nearly any outdoor table by adding a built-in cooler. Dan Knor added a basin to this table, which he made out of beams and battens by cutting a hole in the middle and dropping in a window box for planting flowers. The box tapers down for a tight fit, and since it's not affixed to the table, emptying the ice and water at the end of the night is as simple as picking the box up and dumping it out. Although Knor didn't need a bracketing system, you'll want one if you choose a larger basin. (See below.)

- 1 Find a metal box big enough to accommodate your drinking habit.
- 2 Measure your table to find the centre and cut a hole to the dimensions of the metal box.
- 3 If the box has a lip, it will make for a nice finish on the table. If not, you'll need to permanently mount it under the table, similar to an under-mount sink.
- 4 Attach four L-brackets to the bottom of the table and the basin.
- 5 Use a metal bit to drill a drainage hole in one of the bottom corners of the basin. Plug it with a wine cork.
- 6 Fill the basin with ice and your favourite beverages.



3 CONNECT TO THE POWER SOURCE.

Ring terminals for motorcycle batteries come in standard sizes. Hook the ring terminals to the battery and solder the other end – or connect it using push-on terminals (fig. 2) – through the fuse and onto the charger. On an appliance you splice into that 12-volt line. Use a piggyback-style push-on terminal, which splits the line in two and will get electricity to your charger without sacrificing the lightbulb.

4 CHARGE. Plug in your device. If you've installed the charger on something battery-powered (like a motorcycle), make sure to unplug it when you're done, otherwise you'll drain the battery.

Fig. 1

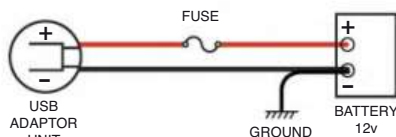
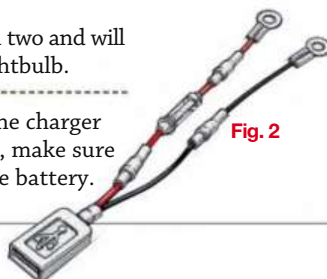


Fig. 2

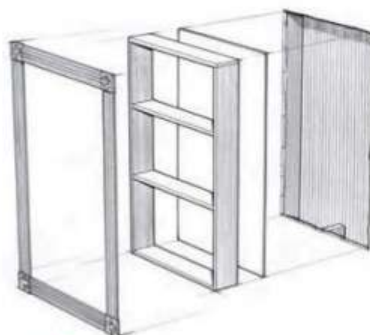




HOW TO MAKE

A bookcase inside drywall

Depending on your home, there could be a good 100 to 150 millimetres of unused space behind your drywall. Here's one way to put it to good use.



- 1 Find two studs and make a 75 x 75-millimetre exploratory hole in the drywall between them to see if any wiring, plumbing, or ductwork is protected by the wall. If not, proceed.
- 2 Using the studs as the sides of your bookcase, mark the bookcase opening on the wall with a level, a tape measure and a straightedge.
- 3 Use a drywall saw or an oscillating multitool to cut along the lines and remove the piece of wall.
- 4 Cover the rear surface with a thin sheet of plywood, and build a four-sided pine frame to fit the opening. It should be flush with the surface of the wall.
- 5 Paint the frame, plywood and any shelves.
- 6 Insert the frame in the opening and attach it to the studs with screws. Add shelves using small brackets screwed through the frame and into the studs.
- 7 Install trim around the frame by nailing the vertical pieces to the studs and gluing horizontal pieces to the drywall.

HOW TO MAKE

Steak sauce

BY CHEF
CHARLIE PALMER

Makes about 1 cup.

In a medium mixing bowl, **combine:**

- ¾ cup tomato sauce
 - ¼ cup Worcestershire sauce
 - 1 Tbsp molasses
 - 1 Tbsp apple cider vinegar
 - ½ Tbsp soy sauce
 - 1 Tbsp orange juice
- Stir until smooth.

In a large pot, **sweat:**

- 1/8 cup chopped onions
 - 1 tsp chopped garlic
 - 1 tsp chopped ginger
- Onions should be translucent.

Add in:

- 1 Tbsp light brown sugar
- 1/8 tsp allspice
- 1½ tsp celery seed
- 1 tsp black pepper

Cook on low for about 2 minutes, stirring slowly, until the sugar begins to break down and melt.

Add the wet mixture to the pot and simmer for 1 hour.

Transfer to a blender and **puree.**

Let cool before serving.



Chef Charlie Palmer has won two James Beard Awards. He opened

his first restaurant in New York City in 1988, and has since expanded his empire to include 13 more restaurants.

PHOTOGRAPHS BY BEN GOLDSTEIN

HOW TO MAKE YOUR FRIENDS HAPPY

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HOW TO MAKE

A lampshade

You can make a lampshade out of pretty much anything – watered silk stretched over hammered coat hangers, corrugated steel, copper tubing strung together with wire . . . or twine and glue, like this one.

BY ANN QUIGLEY



A TOAST

1. Put down your notes and wing it.
2. Make sure Grandma isn't there before you work blue.
3. Keep it shorter than you want to.
4. Save the sweet stuff for the end.

1 Find an inflatable ball, such as a beach ball, a little smaller than you want the lampshade to be.

2 Pour a 300-millilitre bottle of craft glue into a bowl. Any brand that dries with a clear, matte finish will work.

3 Dilute with a quarter cup of water.

4 Cut twine into 1,2-metre lengths and swirl them around in the glue until they are fully coated. I used hemp and fluorescent-yellow mason twine from a home store.

5 Wrap the twine around the inflated ball, overlapping the different strands. Leave a 75-millimetre diameter hole over the inflation valve of the ball. You'll use that to pull the ball out when the glue is dry. Also, that's where you'll hang your lightbulb.

6 Let dry overnight.

7 Deflate the ball and remove it from the lampshade. You'll have to do a bit of gentle prying to disengage it from the glued strings.

8 Affix the lampshade to a plug-in or hard-wired pendant light fixture, which you can find at home stores. I cut a small hole in a yoghurt-container lid to suspend my string ball around a lightbulb, but you might find a more elegant way to do this using wire or an aluminium sheet.

HOW TO BUILD

A smoker

You don't need a steel drum or a welding kit.
Just a wine barrel, inspiration from Instructables, a few fire rocks, and two hours.

BY ROBERT VRABEL

1 BUY A WHISKY OR WINE BARREL FROM A LOCAL DISTILLERY, vineyard or online.

2 BEFORE CUTTING OFF THE LID, drill self-tapping screws through the metal bands to fasten them to the staves. This will prevent having loose, shifting staves once you cut them off from the rest of the barrel. If your staves are wider than a few centimetres, use two screws per stave for increased stability.

3 CUT THE LID OFF THE TOP OF THE BARREL with a jigsaw at least 10 or 15 centimetres below the first band.

4 TO CREATE AIR INTAKES, DRILL THREE 20-MILLIMETRE HOLES BETWEEN THE SECOND AND THIRD RINGS FROM THE BOTTOM. Screw 20-millimetre NPT nipple fittings into the holes, leaving some of the threads sticking out of the barrel so that you can add NPT end caps.

5 DRILL A SMALL HOLE FOR YOUR TEMPERATURE GAUGE IN THE LID. Make sure it's a snug fit.

6 FASTEN A HANDLE – ANY GENERIC HANDLE WILL DO – TO THE TOP OF THE LID. Drill three holes in the lid, just big enough to fit three more 20-millimetre nipples. You'll add or remove their end caps to adjust the temperature during smoking.

7 LINE THE BOTTOM OF THE BARREL WITH FIRE BRICKS TO CONTAIN HEAT. Without blocking any of the air intakes, stand bricks every 10 to 15 centimetres around the inside

of the barrel. This frame will support the bottom grate and serve as a cradle for your water pan.

8 ADD THE BOTTOM GRATE. You'll place charcoal on top of the bottom grate, then wrap smoking chips for flavour in aluminium foil and place them directly on the charcoal.

9 SCREW FOUR 90-DEGREE BRACKETS ALONG THE INSIDE TOP EDGE OF THE BARREL. Place a grate on those brackets. This is where your meat will go.

10 START WITH SOMETHING EASY, like pork shoulder (see right).

HOW TO SMOKE A PORK SHOULDER

BY ALLAN BENTON,
BENTON'S
SMOKY
MOUNTAIN
COUNTRY HAMS

1 Buy a 3- to 3,5-kilogram bone-in shoulder.

2 Combine coarse ground salt and coarse ground pepper, and rub it into the pork.

3 I'll start some hickory wood burning in the evening, let it get down to some nice, hot coals, and put those in the smoker with the meat.

4 Let it smoke all night, and by late morning, when you see the meat drawing away from the bone, it's ready.

5 Check the internal temperature (at least 63 degrees). Let it rest a few minutes. Add your favourite sauce and serve it up.

This smoker was built by
Andy Northshield of
North Salem, New York.

5

The computer creates more energy than some of its parts can withstand, so they are cooled through this external radiator.

1

Silicone tubes carry a mixture of distilled water and additive, the same kind used in radiators. The additive breaks down the water's surface tension, exposing more molecules to the heat from the circuit board. The heat is absorbed by the mixture and transported to the thermal tanks.

4

The organic phase-change material emits heat as it returns to a solid state. That heat is transferred from the tank by these silicone tubes to a basic fan-coil radiator that blows air over the coil, extracting heat and dispersing it into the room. The unit can also be plumbed to work with a water heater.

2

Brass plates about the size of index cards are bolted directly to the graphics cards, which reach temperatures of 98 degrees. The plates, called heat exchangers, draw heat without interrupting the circuit board's operations.

HOW TO USE

A computer to heat your home

If you've ever used a laptop on your actual lap, you know how hot computers can get. You could grab a pillow and protect your chances of fathering children, or, like Lawrence Orsini, an energy consultant in Brooklyn, New York, you could use that heat to warm your home. Orsini created a device he calls Henry – a working desktop computer that transfers the heat from a circuit board through a series of pipes and reservoirs and into his apartment, saving him a fortune each year and giving him something to look at in the living room other than the TV.



– HAN ZHANG PM

3

Heat energy collects in two sealed and pressurised 20-litre metal tanks in the base. The tanks contain fatty acids and esters – organic phase-change material that shifts easily from liquid to solid and back as it harvests and disperses heat.



THINGS YOU SHOULD LET OTHER PEOPLE MAKE FOR YOU

croissants

diamonds

crossword puzzles

deodorant

fireworks

business cards

vaccines

child's car seat

diploma

TAKING ON *the world*

For the first time, competitors from Africa will line up on the starting grid for the annual World Solar Challenge.



Locals know it as The Track. The Stuart Highway is a lone paved road that snakes through Australia's Northern Territory, traversing one of the most starkly beautiful – and most spectacularly desolate – regions on the planet. And later this month it's where the enormity of what they are undertaking will surely hit an elite gathering of solar-energy racers.

That's when the 2015 Bridgestone World Solar Challenge gets under way in earnest. Teams from all over the world converged on the northern port city of Darwin where, on 18 October, they will set off to race 3 000 Sun-powered kilometres to Adelaide in South Australia.

And for the first time among that number will be two teams from Africa. The University of KwaZulu-Natal's *Hulamin* and North-West University's *Sirius X25* will carry the flag for the continent. A total of 47 teams from 25 countries will be taking part in three classes and both local teams are entered in the primary racing class, Challenger.

The South African teams are no strangers to the heat – sometimes literal! – of competition. In last year's local equivalent, the 2014 Sasol Solar Challenge, they were the first local teams home. *Hulamin* finished third and *Sirius X25*, fourth, just 60 kilometres behind.

UKZN describes *Hulamin* as the culmination of hard work and dedication from some of the university's best engineering students, and represents innovative and energy-efficient engineering design,

promoting green energy for the future. Previously known as *Hulamin* – *iKlwa* and now rebranded *Hulamin* after the aluminium manufacturing company that funded it, the car has been reworked and upgraded with one goal: to qualify for the 2015 World Solar Challenge.

UKZN's joint Solar Car Project leader Dr Clint Bemont didn't mince his words. "We are going to Australia to win," Bemont says. "We hope to beat teams from some of the best universities in the world... Stanford, Cambridge, MIT, even Delft." The car, an undergraduate engineering final-year project, is supported by a team that includes students and staff from the university's departments of electronic, computer and mechanical engineering.

According to the World Challenge organisers, based on the original notion that a 1000 W car would complete the journey in 50 hours, solar cars are allowed a nominal 5 kW hours of stored energy, which is 10 per cent of that theoretical figure. All other energy must come from the Sun or be recovered from the kinetic energy of the vehicle.

To complete the 3 000 kilometres, teams have seven days. The winner will be aiming to do it in five. On your marks...



FACTS ABOUT THE WORLD SOLAR CHALLENGE

- Total distance more than 3 000 km.
- Takes place 18 to 25 October.
- Racing for the day ends at 5 pm.
- Teams have to make camp wherever they find themselves at that stage of the race – they have to be self-sufficient.
- There are seven mandatory checkpoints, at which teams are allowed to perform only the most basic maintenance, such as checking tyre pressure and cleaning the vehicle.
- The Challenger class is conducted in a single stage from Darwin to Adelaide.
- The Cruiser Class is conducted in two stages, with a compulsory overnight stop in Alice Springs where teams may recharge from the grid.
- The Adventure Class is also conducted over two stages, with an overnight stop in Alice Springs.
- To find out more, visit worldsolarchallenge.org

HULAMIN



Five metres long and weighing under 250 kilograms, *Hulamin* has an asymmetrical design, with a highly aerodynamic profile and very small frontal area. The theoretical drag of the car is very low, at 0,07.

Although lightweight the car is rigid and safe, with a fully carbon-composite monocoque chassis. It will have 6 m² of super-high-efficiency silicone solar panels to harvest energy from the Sun. This energy can be stored in 21 kg of lithium-ion batteries.

SIRIUS X25



The R1,5 million *Sirius X25* is designed by a multi-disciplinary team of students from NWU's Faculty of Engineering under the guidance of team project manager Professor Albert Helberg. Weighing just 208 kg without the driver and 4,5 m long, the *Sirius X25* has lower wind resistance than some of the best sports cars in the world. Although it typically travels at 80 km/h on level terrain, it can reach 140 km/h. And it does all this while consuming less energy than a standard household lightbulb.



4

SOLO

IN THE FINAL STORY OF OUR FOUR-PART SERIES,
THE AUTHOR GOES AFTER WHAT HE WANTED ALL ALONG,
THE THING MAN HAS WANTED FOREVER:
TO FLY.

BY

JOSHUA
FERRIS

PHOTOGRAPHS BY
DANIEL SHEA

I'M NOT A PILOT. I'M A WRITER.



I was commissioned by POPULAR MECHANICS to write about learning to fly, a commission I agreed to after a few days of deliberation, mainly, and perversely, because I'm terrified of flying and I figured I'd have something to say. I had expressed a desire to fly solo, as the culminating event of my flying lessons with Tom Fischer of Fischer Aviation, but from the first moment of my first lesson, when I was quite out of my mind with disbelief and anxiety and regretting soulfully this awful decision, I did not think a solo flight likely at all.

Most days I had to encourage myself to do the adult thing and continue: to leave the apartment when I might have otherwise been at work on a novel, to face down the scorn of a resentful parking attendant and retrieve my Zipcar from the bowels of the nearest garage, to drive over the George Washington Bridge in the perilous midday traffic, to fill up the tank and eat on the go and be on time – all of the many everyday adult things I'd worked so hard my whole life to avoid. And then to submit again to the Piper Cherokee we called Six-Two Romeo, to the current condition of its engine and landing gear, to a faith in the diligence of mechanics and my own eyeballing inspections, to Tom Fischer's expertise and the expertise of all those circling the Caldwell Tower traffic pattern with us that day, and to my own undetermined fate. I did this throughout August, September, October, November and December of last year, three times a week, as withering sun and heat turned to ice and snow, interrupted twice by weeklong business trips, by sickness and bad weather, and by the old yearning to write.

A single commercial flight, with its wobbling takeoff and changes in engine noise, was usually enough to convince me how wrong this whole enterprise was: the vast airports, the teleport-like travel times, the entire infrastructure upon which our interconnected and globalised world is so heavily premised. If I had been alive before human flight was an established matter of fact, I would not have been the man to gaze upon the bird and declare, By God, I can do that! I would have been the man who retreated from the doorway and turned back to the scene between two make-believe characters unfolding on his desk in a dark corner of the hut.

I was equipped with an overactive imagination, one prone to extremes and inclined towards the morbid, and so I can and do dwell often enough on my death and accommodate death's subconscious forays into my daily happiness, without having to go up in a plane. Death is often depicted in movies and in comic strips as coming for people, wearing his black cloak and carrying

his black scythe and suddenly appearing beside the unsuspecting and the incredulous, but it was the opposite with me: involuntarily, burdensomely, I went thinking and sniffing after death many times a day, to try it on, to realise limits, to rage, to attempt once more to comprehend the mortal arrangements of a puzzling world. Life was puzzling and it was hazardous and it was short. I could imagine a hundred ways of dying in my own house, in

my bathrobe, while only reading the *Times* and eating a bowl of cereal. Why did I need to complicate matters by learning how to fly?

I wasn't flying because I got a great big Maverick-and-Goose thrill out of being up in the sky. Not until very late in the process did I consider the practical angle, the possibility of flying myself to Key West for the weekend and enjoying a weekend in Key West before flying myself home, because by that point my wife had come up with Tom and me in Six-Two Romeo and declared herself "scared shitless" for the entire two hours. "It was the most frightened I've ever been in my entire life," she said, forswearing ever going up in the air with me like that again, and if my wife wasn't going to fly down to Key West with me for the weekend, I wasn't going to go alone, so the practical angle, which didn't come to me until late anyway, wasn't the reason I agreed to fly.

I don't know why I agreed to learn how to fly. The truth is, I don't know why I do *anything*. I've been trying to understand, first, why I agreed to fly, and second, why I do anything at all, from the very moment I agreed to learn how to fly, because learning how to fly had a way of focusing my attention and forcing me to confront the certainty that I would die, which is the necessary backdrop to asking all sorts of questions about purpose and meaning and what makes life worth living.

The only reason I could possibly agree to learn to fly was so that I could write about it. I wouldn't have learnt to fly just to fly. Writing, for me, was the reason life was worth living. What other people did to get the most out of life, I did in the service of writing. Even if, as with the case of flying, the only way to get the most out of life was to risk dying. I comprehend fully the absurdity of this condition and readily admit that it makes no sense. And please understand me, I had a lot to live for. I had a wife and a son who make me very happy. I had just watched my father die in Chicago, at age seventy-five, after a long bout with cancer, and I really only wanted to come home and stay home and enjoy the company of my family and grieve. But after he died, I came home and began my flying lessons. It seemed to me that I went from the funeral home to the flight school, from the end of protection to the start of great peril.

I was always in good hands with Tom Fischer, who had more than nine thousand hours of flight time and possessed the confidence and demeanour of a general in the Air Force, but Tom would never be my father, who had zero hours of flight time and only ever wanted to take me to Wendy's for the dollar menu before we settled into a weekday matinee. At the end of my time with Tom, it was my intention to fly solo. I didn't want to solo, but I was writing about learning to fly, and when learning to fly, soloing was the inevitable dramatic conclusion. But when I'd imagine soloing, I'd imagine being a few thousand feet up in the air looking at the instruments that I still only half understood, at a control panel I could not interpret, in a perfect cone of death's white noise, muted, helpless and uncom-

Joshua Ferris is the author of three novels, including *Then We Came to the End*, a finalist for the National Book Award, and *To Rise Again at a Decent Hour*, nominated for the prestigious Man Booker Prize the first year American writers were eligible to receive it. To read Joshua Ferris's "Learning to Fly" series in its entirety, go to popularmechanics.com/learningtofly.



• municative, like my father on his deathbed in Park Ridge, Illinois.

For the first dozen lessons or so, when Tom and I would walk out together through the parking lot with the can in hand – the metallic logbook where flight time was recorded, which also contained the keys to Six-Two Romeo – I would be sick with apprehension. Stepping inside Six-Two Romeo to retrieve the checklist and fuel-tester cup, walking around the plane doing the preflight check, getting back in and starting the propeller, taking down the ATIS data (weather conditions, runway availability), calling ground control for permission to taxi, and then taxiing to the runway, I was in a constant state of denial about what I was about to do. I was, in fact, about to race down a runway streaked violently with brake marks until I reached seventy miles an hour, then pull back on the yoke to lower the stabilator while applying right rudder to keep the plane steady as it entered the air, then rise over the wall of trees that stood at the end of the runway like a tribunal of final judges, and over the golf course that, still but five hundred vertical feet away, looked so mortally close, all while hoping for the continuation of a positive rate of climb entirely dependent upon an engine whose sudden sputtering and stalling out I was listening for every unfolding second.

But here's the good news I have to share with you, if, like me, you are afraid to fly: by taking off and landing in a small single-prop several times a day, sooner or later you stop being afraid. Perhaps not entirely, but by the time Tom and I took my wife up in the air and we came back down and she declared herself scared shitless, I could only laugh and laugh, because I understood so well exactly where she was coming from, but I was no longer there. My fear just wasn't there, it was no longer equal to hers, where once it had been even more potent. I had been taking lessons for two or three months by then, and without realising it, I had, over time, by systematic exposure to episode after episode of terror, damn near completely lost my fear of flying.

But to solo? The word itself made me shudder with dread. I was worried that I would panic, or choke, or suddenly blank on something essential. Blanking wasn't unprecedented. Take the time I tried to land on the runway while still flying too high and

too fast. It was a beautiful day, cold but bright, with good visibility. We were at the end of October. As we went up, the trees, whose leaves had turned by then, extended for miles and looked, from that unique vantage, like the bunched feathers of some fantastically coloured thing. All of New Jersey had a feathery shimmer that day, cut away here and there by the still eye of a lake or an empty baseball field, and in the distance, the Manhattan skyline stood geometrically erect like so many assorted math supplies.

Tom and I had run through manoeuvres over the onion fields – slow flight, steep turns, and stalls – before doing simulated engine-out landings at the uncontrolled Orange County Airport just north of Caldwell. Tom would reach out as we approached the runway and take all the power out of Six-Two Romeo, the cockpit would fill with silence, and the plane would quickly start to sink, and by this I understood that we were practising how to land during catastrophic engine failure. To reach the runway and to set the wheels down safely and gently, I was allowed to use only that glide still inhering in the plane.

I did this moderately successfully a number of times, and then it was time to head back to Caldwell and call it a day. I was really pleased by how I had handled those simulated engine-out landings, and had no particular anxiety about the final landing of the day, since that would be done with the benefit of power. But I hadn't counted on the confusion, the spatial muddle that occurs when, for the previous two hours, you've been playing around in a wide swath of practice area and then abruptly enter a tightly regulated traffic pattern like the one at Caldwell, where strict rules for altitude, speed and landing order are dictated by an unforgiving tower. I found myself coming in too close to the runway during the leg of the descent called the downwind because I couldn't quite settle down or get my bearings, and a crowded downwind pretty much determined that my next leg, the base leg, which is the leg you travel just before you turn one final time and head directly at the runway, was going to be super short if I hoped not to overshoot the runway. In other words, I left myself with no time to descend or slow down on my final approach to the runway. I didn't recognise what I was seeing, and without a familiar sight

picture, I blanked on how to slow and how to descend and reverted to the bad habits of the beginner pilot.

A trained pilot always allows an airplane to descend in a measured way, much as a balloon drifts down and down as it makes its slow way across a room, but poor instinct tells the beginner pilot to land by pointing the nose of the airplane at the runway like a dart. Now, the one certain result of pointing the nose at the runway is to make a fast plane fly that much faster. So at the exact moment in time that I should have been slowing down before locking the plane in to a consistent airspeed, I was speeding up.

You can just imagine Tom sitting next to me, wondering what on earth I was doing. He was beside me when, just a moment ago, I had executed any number of simulated engine-out landings. I hadn't been aiming at the runway then. What had come over me? "Don't nose down," he warned me. But I continued to nose down. I wasn't listening to him. In my ignorance and confusion, and with the confidence I had acquired doing those simulated engine-out landings, I must have believed I had it all under control. "Bring the nose up," he said to me a second later. I'm not sure I even heard him. "Nose up now!" he demanded. But I continued to nose down until he had no choice but to override me on the controls and save us from the consequences of what would have been a very bad landing. "I don't know what I was thinking," I said to him later. He replied, "I don't know why you weren't responding to the prompts I was giving you. I said them several times before I did anything about it myself."

If I couldn't even hear the man when he was next to me in the plane, what would have come of me if he had not been there at all? At any moment, it seemed to me, my mind might fix on the wrong idea, the wrong approach, the wrong solution, and on a solo flight, with no one in the plane to override the controls, I would drift unwittingly into an accident chain that I would not be able to pull myself out of. "Something goes unnoticed, uncorrected, unaddressed," Tom once said about the accident chain, "and it snowballs until you're out of options."

The accident chain as a metaphor for death in general does a decent job of describing how my father died: the pancreatic cancer that he had, by some miracle, outlived for seven years after his initial diagnosis had set into motion a chain of surgeries and illnesses that in time got the better of him and, with the return of tumours to his lungs, wiped him out. I loved my father a great deal. All my life he protected me and cared for me as no one else had, and watching him die had a profound impact on my mental and physical health.

I didn't know it at the time, because I believed I was looking death in the eye bravely and maturely, as only the happiest people do, but death is insidious in all sorts of ways. The world in which my father was unable to be reached at any time of day or night for support or comfort was not a recognisable world, and I started having insomnia and anxiety attacks. I woke up every two or three nights just a few hours after nodding off, my heart racing, unable to catch my breath, and still menaced by the final frames of some lingering nightmare. I had an anxiety attack on a stage in Canada and at the historic Piazza del Campidoglio in Rome before an audience of a thousand. Instead of considering that I might be suffering from grief, I attributed these attacks to my own demise.

You see, I'd watched my father so closely in those final days, seen him waste away and grow incoherent with no recourse or



reprieve, and the close study made me paranoid. Death was pitiless and indiscriminate; if it could come for him, it could come for me. I must be dying. My death was manifesting itself in sleeplessness, anxiety and odd little ticks that interrupted my sleep. I went to doctors to confirm the news, and when they gave me clean bills of health, I knew sly death had done something to elude them.

The truth is, I was a mess. I wasn't taking care of myself. I wasn't eating right. I wasn't exercising. I was drinking too much. And I was having those attacks and nightmares. You think you're safe in sleep, you think you're beyond fear, but the reeling mind is most vulnerable a few hours after midnight. I would wake to the middle of a living nightmare: no one else awake, no one even stirring, the absence of my dad rendered absolute and universal. I was like a man in solitary confinement from two in the morning onward, nothing to do for hours but watch the unremittably black windows for the grey to creep in. And then I would go fly.

That was the flow of my days and nights: nightmare, insomnia, anxiety, flight. Flight, anxiety, exhaustion, nightmare. Grief vibing throughout. I should have quit, and thought about quitting many times, but I had agreed to write about the experience for *POPULAR MECHANICS*, and they had already put out quite a tidy sum to get me where I was. Plus, I had never quit anything in my life. Also, it was possible that I was improving. Tom seemed to indicate from time to time that I was improving. I couldn't say one way or another, as I could concentrate only on my mistakes and bad habits. I seemed, in fact, capable of dwelling only on the

negative, the morbid, and the fear, which confirmed for me that, when provided with something fun to do, like learning to fly, my looping, stunted, amygdala-heavy brain managed to make it a total drag.

Earlier in the year I had gone to Antarctica, another fun and rare adventure that had nevertheless proved trying in the extreme at various points over the course of our 21-day expedition. In particular, I was dismayed one night when, at the helm of the ship, the Dutch tall ship called the barque *Europa*, I accidentally steered the wrong way right at that moment in time when the wind, which had been virtually nonexistent for several hours, finally picked up, allowing us at last to make good time through the Drake Passage. I was as eager to do so as everyone else, but I got confused by so simple a thing as the wheel, and mistakenly believing that I should steer clockwise in order to keep us on the correct heading, I went clockwise, and soon the sails began to luff. The captain, who was at the bow, came running back, demanding to know what I had done. "I screwed up!" I cried.

Should a person incapable of operating so analogue and straightforward a thing as a wheel on a boat allow himself to go up alone in an airplane? I didn't think so.

But as I say, Tom seemed to indicate from time to time that I was improving, so much so that one night after practice I heard him say to me, "Don't dawdle on the medical." Now, a medical is an airman's physical, which the FAA requires the novice pilot to pass before taking his first solo. Tom was telling me that with my medical in hand, he could extend the invitation for me to solo at any time. He took it on faith that I wanted to solo, whereas I really hadn't yet made up my mind. I felt no more fear, or very little fear, anyway. I was comfortable in the cockpit. I was proficient at the controls. I might have stopped myself right then and asked, "How did I get here?" Because for so long none of

**"A MISTAKE GOES
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that was true: I was neither comfortable nor in command. But here is the truth: I, the scaredy-cat, the little mimsy boy, had learnt to fly. Anything is possible in this world. Anything. Don't get me wrong: my landings still needed to be more predictable and consistent, but that was just a matter of practice.

So the question came to me: was the decision not to solo a matter of principle, even a superstition? Was I rigidly opposed to going up on my own under any and all circumstances, or was I flexible enough to reassess the situation in light of new information, namely, my improved proficiency and Tom's own confidence? Tom wasn't about to let me go up on my own if he didn't consider me capable. His life wasn't on the line, as mine was, but everything else – his livelihood, his teaching career, the reputation of his flight school – was. He wasn't cavalier about the decision. I could take great encouragement from his remark not to dawdle with the medical. Still not knowing if I could in fact solo, soon after Tom's remark I saw a doctor, Dr Schneider, for my airman's medical.

I also decided that I needed to do something about how I'd felt since my dad died, when my first bouts of insomnia hit. During critical moments of flight, Tom would encourage me to "get organised". By this he meant that I needed to settle the plane down: level the wings, address the rudder, adjust the speed, ease the climb – whatever was needed to steady her out in order to continue on a path towards straight and level flight. It was like that for me personally. My fears were unsteady my mind. My mind was attacking my body. My body was indulging its worst appetites. Those appetites were disrupting my sleep. My sleeplessness was compounding my fear. I was falling out of my own personal sky. It was time for me to get organised.

The first thing I had to do, I thought, was stop drinking. A lot of grief came from my drinking, not so much that you would call me an alcoholic, but enough to wonder what my life would be like without it. For one thing, I thought it might help me sleep better. So at the beginning of November, just as I turned forty – I mean the day I turned forty – I gave it up. I slept better immediately. My anxiety load dropped. The nightmares went away. I no longer drifted off during unrelated conversations into morbid reveries of all the ways I might die during a solo flight. More sleep and less anxiety, and a therapist to help deal with the grief, together with quitting drinking, pushed back the spectres and phantasms that had been creeping up on me for months. The whole breathless worry of death abated just a little.

I HAD MY FIRST SUCCESSFUL solo flight on 26 December, 2014, nearly five months after I began my flying lessons. I still can't explain why I decided to solo any more than I can understand why I agreed to learn to fly, unless it is to say that I could solo, just as I could learn to fly, and like the man who looks at the bird and senses the possibility of human flight, what is possible is often simply what is done. That is the human record, to the world's delight and the world's dismay.

I don't want to oversell it, but if I needed any reassurance that year that I was not dying as my father had died and that I had things to live for despite his painful absence, I found it that day in front of the double lines of the runway waiting for clearance from air traffic control, when I knew that despite being hobbled and despite being anguished, I had prevailed over my grief and my fear and overcome a not inconsiderable amount of technical challenge to prove to myself that I was still mentally



sound and ticking. I was in Six-Two Romeo absent of all expertise and guidance but my own, and took her up in the air by myself without reservations or second thoughts, and as I circled the pattern, I whooped with happiness and pumped my fist in victory and failed to repress a smile so insistent that it began to hurt my face. It was absurd but true: an unrelieved and cheesy smile was the closest I came to hurting myself during my solo. It was such pure, undiluted pleasure to be up there on my own, a long brain bath of endorphins and joy, much more fun than I had anticipated. It wasn't until then that the fuller story came into view.

I'm not simply someone who takes a fun thing and turns it into a drag. Matters of life and death, which are the only things worth considering, demand to be taken seriously, and must be wrestled with as Jacob wrestled with the angel, and when at last the struggle is over, you have truly earned something, and your happiness is not easily acquired or short-lived, and not likely to be forgotten in your lifetime.

"I always tell people," Tom said to me more than once, "it's a lot of fun, but it's not a game."

"With me," I once replied, "you could have said, 'It's not a game, but don't forget, it can also be a lot of fun.'"

Because the fact is, I had to work at having fun inside the airplane as much as I had to work at controlling my rate of descent or reading the aviation maps. Mindless testosterone fun was not my way. Deliberation was my way. Overthinking was my way. Fun did not come to me inside Six-Two Romeo until I had earned it through mortal worry. Only then could I whoop and holler like your average flyboy buzzing the towers of New Jersey.

After three takeoffs from Caldwell Airport and three full stops, or about forty minutes of solo time, I picked up Tom at the apron on my way back to where we parked Six-Two Romeo. I don't hesitate to say that I wanted to please and impress Tom. Your flight instructor sees you at your worst, day after day at your mincing, anxious, hesitant, erring, stubbornly confused, unconfident worst, so when at last you do something worthy, you feel like a little boy longing to be celebrated for his bravery and triumph.

And Tom knew how scared I had been. Before our very first lesson, in the wake of grief, deprived of sleep and personally disorganised, I had confessed to Tom that I might be slipping.

"What are we talking about here?" he asked. "Are you putting your pants on backwards?"

He looked at me, waiting.

Because we didn't yet know each other, and because I had basically just walked in off the street and confessed that I might be slipping while also proposing to go up in the air with him and pilot around in his airplane, I felt the need to walk my comment back.

"No," I said. "Nothing like that. I think it's just because I'm turning forty."

I explained it away as a simple matter of ageing. But over the course of my time with Tom, as we got closer, I took him into my confidence. I told him the extent of my fear of flying, and I told him about my dad and my months of grief.

When he got back into the plane with me after my solo and we parked Six-Two Romeo, and the propeller wound down and we removed our headsets, he turned to me and half-smiled and said with pride something I'll never forget, which pretty much nailed the feeling I had just then, and the feeling I hope to keep alive in me for many years to come.

"Long way from terrified," he said.

PM



#INSIDEOUT

A LAPTOP WHEN YOU NEED IT A TABLET WHEN YOU WANT IT

Why choose between a laptop or a tablet? 2 in 1 devices with Intel[®] processors deliver a transformative experience for work and play on-the-go. Get the best of both worlds with a cutting edge design and ultra-fast performance all in one device. Easily switch between productivity and entertainment in a flash. Step into the next dimension with Intel[®].

THE KIDS ARE ALL RIGHT

The Cape Peninsula University of Technology innovation day proved that the future of South African engineering is in good hands, says Lindsey Schutters.

I'VE SEEN THE FUTURE. The future is 10 cm^3 satellites orbiting 600 kilometres above our heads, collecting data on their 15 Earth rotations per day. In the future, we'll recycle all our plastic in private gasification units, our food comes in capsules about the size of a pain pill, we recycle all of our textile water and our rooftops are aquaponic farms.

That entire vision took one sweep of the exhibition floor at the Cape Peninsula University of Technology Innovation Showcase to realise. Yes, a couple of student projects in a sports hall on the fringes of Bellville do not the world change, but it represents so much more than that. These events strip away the distance between theory and practice and open the students up to market criticism.

Where the maker movement showcases the best of the backyard tinkerers and part-time engineers, tertiary programmes produce the professionals who will shape our world. The ideas of tomorrow are dreamed up today. These are a few of them.



F'SATI CUBESATS

The French South African Technology Institute partnership has already launched one satellite into orbit with another launch planned for early 2016. These nano-satellites can be customised for all manner of Earth monitoring, from sea safety to weather, and also double as a communication relay.



ADAPTRONICS COASTAL OBSERVER SMART BUOY

Modular sea observation units are the meat and potatoes of university technology, and CPUT is right up there with the best in the country.



UNMANNED AERIAL SYSTEMS

While unmanned aerial vehicle technology is hot property right now, the drone market is a bit saturated. The CPUT Masters students designed a solution that uses a one cylinder, four-stroke engine which runs on a mix of petrol and 2-stroke oil and has a 500 km maximum range. Units are being deployed to assist in surveillance to help fight rhino poaching and monitor activity on Table Mountain.

H₂O PHOTOTREAT

The chemical engineering students were a bit shy to show off their nanopowders because the concept sounds a bit lame. In practice, they're targeting a textile industry that flushes away millions of litres of water because it's been contaminated with dye pigment. Add in the nanopowders to clean out the pigment and you can recirculate the water for a more environmentally friendly solution to man's need for brightly coloured garments.



WHITE BISON SOOC STUDIO

This portable, foldable photo studio is so clever that we're getting one for our office. Order yours for R3 599 at whitebison.co.za



IMAGINATE PIVOT

Another example of clever industrial design is the Pivot key management system. Thread in your keys and you have a Swiss Army knife for your house.

MODULAR SOLAR POWERED AQUAPONICS UNIT

A solar panel powers a water pump that sends nutrient-rich water from a fish tank (with live fish in it) into a growth bed where you grow vegetables hydroponically. The beauty of the system is that the plants and growth medium filter the water, which is then pumped back into the fish tank. You can also eat the fish.



FORMULA STUDENT RACING CAR

CPUT students have competed in the Institution of Mechanical Engineers Formula Student annual event at Silverstone for a number of years and this car was their entry for 2015. To get to the racing stage cars must meet certain strict sustainability, design, safety and business plan criteria and the team has always made it to the track portion. Alternative fuels and carbon emissions reduction are also required.

AIS SMART METER

It's the one time when the "A" in AI doesn't mean artificial and that is a crucial difference. Ambient Intelligence 9 is a smart meter that hooks into your power grid and connects to a companion smartphone app. Connect the unit to your home Wi-Fi and you can monitor energy consumption. If you daisychain units with individual appliances or devices you gain remote control for those devices.



WASTE PLASTIC GASIFIER

Doctor Marco Adonis and his team have big dreams of corporate funding and government deployment for their invention. The project combines the talents within the Electrical Electronic and Computer Engineering Department and is incubated at the institution's Centre for Distributed Power and Electronics Systems. The idea is quite straightforward and involves waste plastic bottles melted down in a ceramic infrared heater, the resulting gas being used to drive a generator. Future markets for this technology are predicted to swell to R80 billion in revenue and to play an energy storage role in the microgrid (incinerate your waste when the power is on, then use the gas when Eskom takes it away).



DRIVER'S LICENCE CONTROL UNIT

In a bid to curb unauthorised access to cars, the DLCU incorporates a licence registration system (which is linked to the traffic department's e-Natis) alongside a fingerprint scanner and password authentication. The idea is that only a registered user can operate the car and the authorities can also disable a user for outstanding fines or if the driver is a suspect in an investigation. Hijacking will also be difficult with this system in place.



FLUID VISUALISATION AND CHARACTERISATION SYSTEM (FLOW-VIZ)

Professor Rainier Haldenwang is the head of research at the CPUT Flow Research Centre and he cannot say enough about how revolutionary a product Flow-Viz is. Usually oil companies, for instance, would take samples to a lab for testing when developing a new product or doing quality control on the production line. With Flow-Viz you can build the unit into the system and have an on-site lab with almost live analysis. It may not sound like much, but it's the first international business spinoff from CPUT. One of the partners was trained up to M-Tech level over the duration of the project.

PM

CARS

With only a souped-up golf-cart engine, the Strati prototype can hit a top speed of more than 50 km/h.



HOW TO MAKE ANYTHING

HOW TO MAKE A CAR... IN TWO DAYS

THE LOCAL MOTORS STRATI ROADSTER IS THE WORLD'S FIRST 3D-PRINTED VEHICLE. SOMEWHAT SURPRISINGLY, IT'S ALSO A BLAST TO DRIVE.

Fiat Chrysler CEO Sergio Marchionne recently called out the car industry for the staggering amount of money it wastes in the design and manufacture of cars. His solution is based on classic business principles: consolidate and eliminate redundancy. Local Motors CEO Jay Rogers perceives the same challenge, but he's attacking it from a completely different direction. For Rogers, the problem stems not from business organisation but from the fact that we still build cars the same way we did in 1915, on assembly lines with thousands of individual parts. It doesn't have to be that way, and the proof is parked in his Knoxville, Tennessee, garage, charged up and ready for a drive.

Local's answer to the cost-cutting question is the Strati, the first 3D-printed car. It's a humble (albeit very cool-looking) thing. Built – printed – in Detroit, in collaboration with Oak Ridge National Laboratory in Tennessee, the Strati is a small electric two-seater, the first of many models in Local's plans. Two factories, scaled to employ 100 people each, are under construction now and scheduled for completion by the end of the year. Local plans to build its own cars, but it could also end up working as a supplier for original-equipment manufacturers, some of whom have met with Rogers already. "One of them said, 'This would be great for prototyping,'" Rogers says. "And I said, 'Forget prototyping! This is how you make the car.'" That's the radical big idea, the one that prompted *POPULAR MECHANICS* to bestow a Breakthrough Award on Local Motors last year.

The world's first 3D-printed car is crude by design, its dashboard looking like stacked silicone beads from a caulking gun. Its flanks, meanwhile, are smooth, resembling the



Clockwise from left: Because it's so light, the Strati's steering is unassisted; the fenders are printed separately so that a fender bender won't require reprinting the entire vehicle; the wheels are large-diameter but super-narrow to accommodate high-pressure, low-rolling-resistance tyres.



exposed parts of the BMW i3's matte carbon tub. "We milled the sides to show how that would look," Rogers says. "Some of the other parts are just how they came out of the printer, so you can see that. But we can make it look however we want. You could put a vinyl wrap on it and the car would still be completely recyclable."

The Strati is printed from carbon-fibre-reinforced plastic, a versatile, strong, and relatively cheap material that could enable some new approaches to safety. Thanks to

the nature of 3D printing, where the car is built in layers squirted from the nozzles of a massive printer, you can embed energy-absorbing crash structures or superstrong seat-belt mounts that are anchored deep in the body. You could bond springy bumpers to cushion pedestrian impacts (right now Local is experimenting with a printable elastic polyurethane material called NinjaFlex). And if you managed to catastrophically damage the tub, you could unbolt the motor and suspension, melt

the car down, and print a new one. Of course, the Strati parked in Knoxville doesn't even have seat belts, but it's proof of concept.

The prototype I drove is the third that Local has printed and took about 40 hours. The company is currently looking for an electric-powertrain supplier, so for now the Strati has a beefy golf-cart motor as a stand-in. The rear-wheel-drive Strati is envisaged as a city car, but Rogers isn't blind to the performance possibilities. "If you put a motor with 150 or 200 horsepower in here, it would be a lot of fun," he says.

It's a lot of fun already. The rear suspension rides on an aluminium subframe, and with no distinction between body and chassis, the car feels inordinately solid, substantial. There's some clunking from the stand-in motor, but the car itself is silent. Put a Mitsubishi i-MiEV motor back there and this thing would be a riot.

The last car I tested with a one-piece carbon tub was a McLaren 650S that cost more than R3,5 million. This Strati, lacklustre motor notwithstanding, could cost about R70 000. No, it's not a McLaren. But to the family of five that crams aboard a motorcycle to get around – Rogers recently witnessed exactly that on a trip to India – it might as well be.

Developing countries would love this technology for cheap transportation, but so might the rich guy who wants a thousand-horsepower car of his own design, printed in a production run of one. Or the carmaker that wants to churn out a complete car in ten hours rather than 24, using a fraction of the components. Modern cars are complicated, but the union of 3D printing and electric propulsion – where the motor has just one moving part – points to a future in which that's no longer a given.

We currently take it for granted that cars are complicated and expensive. When you're driving the Strati, it's easy to imagine a day when we take it for granted that they're not.

IN PRAISE OF

THE BORROWED ENGINE

Starring the 2005 Morgan Aero 8.

I recently drove a 2005 Morgan Aero 8, a car that combines traditional Morgan funkiness (components made out of wood, unsymmetrical aluminium bodywork) and a BMW V8. And, I've got to say, what an outstanding combination: the visceral reactions of a hand-made British roadster paired to big, reliable V8 power booming out of side pipes just below the door.

This kind of thing – car companies borrowing one another's engines –



used to happen all the time. The previous-generation Range Rover used V8s from BMW and Ford, and the Saturn Vue once ran a Honda V6, for reasons that were never entirely clear. These cross-pollinations resulted in some strange but fun alchemy. Factory-sanctioned motor swaps aren't as popular these days, but there are a few worthy freaks out there. Run a Scion FR-S through the gears and it'll sound like a Subaru. Because under the hood, that's what it is.

THE POWER OUTPUT PROBLEM

AS CARS GET CARTOONISHLY MORE POWERFUL, MAINTAINING TRACTION IS THE NEWEST ENGINEERING HURDLE FOR AUTOMAKERS.

Five hundred kilowatts is the new 350 kilowatts, and every performance car worth its carbon-fibre diffuser is packing either a supercharger or a turbo. Traction problems were once confined to the launch – once you were rolling, you could hammer down. The new reality is epitomised by the Dodge Hellcats and the BMW M5, cars that could lay rubber all the way down the quarter-mile if you please. With power numbers heading ever higher (who'll be first to 1 000?), finding a way to deploy all that energy is becoming the paramount challenge for chassis engineers. Here are three approaches to keeping big power from going up in smoke.

SOLUTION 1

All-wheel drive

For 2016 Jaguar endowed all V8-powered F-Types with all-wheel drive, thus solving any traction problems that might have afflicted the newly upgraded F-Type R coupé. On a test drive at Monticello it powered through and out of corners at borderline crazy speeds without the slightest complaint. "There's a limit to the acceleration you can achieve with front-engine, rear-drive," says Tim Clark, Jaguar's chief technical specialist for power-trains. "Somewhere between 8 and 8,5 metres per second squared – a little less than a g – is about your limit. Now with all-wheel drive we can reach 10 metres per second squared and above. You can access more of the performance more of the time in more conditions."

SOLUTION 2

Better tyres

What would happen if you mounted a state-of-the-art performance tyre from ten years ago on the 480 kW 2015 Corvette Z06? "The Z06 would fry that tyre," says Oscar Pereda, a former engineer who's now director of marketing for Michelin ultra-high-performance tyres. Over the past decade performance tyres have changed significantly in terms of construction, compounds, and even in the basic



The F-Type's electronic active differential works in conjunction with its AWD system for maximum traction.

matter of size. "The overall diameter's been going up dramatically," Pereda says. "The taller the tyre, the longer the contact patch, and the better the longitudinal traction to put the power down and accelerate. Compounds and internal materials have come a long way. We now have super-high-strength steel belts that are more flexible, so the tyre can conform to the shape of the ground. With the Z06, I think you're getting the maximum possible acceleration for a front-engine, rear-wheel-drive car."

SOLUTION 3

Go mid-engine

Every car in McLaren's line-up is a beast, with the least powerful model cranking out 420 kilowatts. Not coincidentally, every McLaren has its engine mounted behind the passenger compartment, moving the weight distribution rearward,

closer to the drive axle. That's a boon from an acceleration standpoint, but there's a cascade effect of benefits. "It's about straight-line traction, getting the power down, but it's also about cornering," says Dan Parry-Williams, McLaren's chief designer. "With the weight concentrated around the middle of the car, you make it very nimble." You also reduce overall mass (and, subsequently, inertia), since the engine is closer to the transmission and to the rear-driven wheels, quickening response time. Meanwhile the driver is up front, closer to the front tyres, shortening steering inputs. "You can get a good weight distribution in a front-engine car," Parry-Williams says. "But you might have a long propshaft, with the driver seated farther rearward and outboard." So the future isn't solely about deploying 420 kilowatts in the most efficient way possible. It's about doing it with style.



The manufacturing process for Corvette's tyres is kept top secret.





JAGUAR CLAWS OUT

The mildly strained look on the faces of the Jaguar marketing brigade – and the occasional frown – reflected our after-drive banter about a seriously impressive automobile hobbled by pricing, exchange rates, unlikely competitors and whether anyone really buys into that posh Brit schtick. Nut for nut and bolt for bolt Jaguar's new sedan is a mighty achievement that should earn the brand a legion of new followers. The problem is – locally at any rate – price. With the cheapest XE coming in at R534 800, no amount of spin can realistically disguise the gulf to the German equivalents costing at least 50 grand less. (Okay, we do realise that often those equivalents

exclude options included as standard on the Jag.)

But it's the best driver's car, they say. So on to the drive. For a day and a half we journeyed through the winelands and way out to the Little Karoo. Sadly, fog and heavy traffic applied an involuntary cruise control to much of our progress – particularly the part that involved the top 250 kW supercharged V6 version. Still, I can report that the 2.0-litre petrol that was my first drive demonstrated eye-widening overtaking ability. If pressed, I would say that my favourite was the last-driven of the trio of engines, the new Ingenium 2-litre turbodiesel. Never before has 132 kW and 430 N.m of small-capacity diesel felt this refined, this muscular and, yes, this economical: 4,9 litres/100 km indicated.

In any guise, then, the XE really, truly, feels like a Jaguar should. Sporty. Suave. Sophisticated. Will that be enough to stave off the German forces, though? – AD



LAND ROVER DISCOVERY SPORT SD4 SE

ALMOST THERE

My mantra for my week with the Disco Sport was "Think of it as a Freelander 2 plus, and not a small Discovery." And that's exactly what it is; like the Freelander 2 before it it's possibly the most capable softroader (four-wheel drive without a low-range transfer case) you can buy right now, but it lacks the polish of a Disco. Also, the space is quite cramped in the boot area, and oddly shaped because it curves in at the opening. Now that the niggles are out of the way you'll be pleased to know the excellent 2.2-litre diesel is still as torquey and willing as ever and the Terrain Response System will still be able to pull you out of more trouble than you can get yourself into. I would've appreciated 20 mm more ride height, but swapping out the 18-inch rims for 20s would remedy that. Dynamically the car does respond quickly to steering input and turns in well at speed, but then does the typical Land Rover flop which is a characteristic of the long travel suspension. In essence it's a Freelander 2 with seven seats and the world is better for it. Price as tested: R635 600. – LS



MAZDA 2 HAZUMI AUTO DE

FLAWED EXCELLENCE

Small hatchbacks make the world go round and the all new Mazda2 may just speed up the rotation. The old car was great, but became slightly overshadowed by the far superior Ford Fiesta it shared a platform with. Now that the shackles of Ford profits are off, Mazda has poured all its love and good handling characteristics into the littlest model in the line-up. That love also comes with the superb Skyactiv technology engine that's lively and frugal, and, as is the case in this test, a 1,5-litre diesel. Leather and soft touch plastics dominate the interior and the infotainment system feels upmarket with its Mercedes-esque rotary dial mounted just behind the gear lever. On the whole Mazda seems to be positioning itself as more premium and it shows in the build quality and pricing structure. You get the feeling that at maybe R30 000 less this particular model would represent unbeatable value for money. That said, it is priced competitively in its market segment, but lacks one crucial ingredient offered as standard by its competitors: rear park distance control. Price as tested: R259 900. – LS



MAZDA3 2,0L ASTINA 5DR

DISCREET CHARMER

The bigger of our two Mazda options this month underlined just how spoilt for choice local drivers are these days. Not only is the Mazda3 an eye-catching hunk of sheet metal, it's also practical and refined on the move. It doesn't lack for performance, either.

Our test car's extensive convenience-feature specification should cater to most needs, with everything from smart keyless entry (it locks the car automatically as you walk away) to multi-info display. The rather dark but nonetheless cossetting interior has a quality feel to it that hints at money well spent. Really, the Mazda is a car that deserves to do better than it does.

On the drive, I did miss the option of a driver mode switch to select either a



sportier or a more economy-oriented powertrain mode. That said, the Mazda's "thinking" transmission adapts amazingly quickly to sudden changes in driving style – hard on the accelerator or brakes, for instance – by, say, automatically holding on to a lower gear when needed. The smooth-running 2,0-litre Four pushes out a healthy 110 kW, too. Price: R330 800, including a 5-year/90 000 km service plan. – AD

FORD FOCUS ECOBOOST

DOWNSIZE ME



You know all that International Engine of the Year hype? Well, it's true. The EcoBoost is that good. After a week of driving the Focus, we can report that the 1,0-litre three pulls lustily enough to persuade you that downsizing really is the future. With 92 kW on tap, the EcoBoost is, after all, as powerful as the 1,6 it replaces. However, it's significantly punchier low-down, with 170 N.m of torque from just 1 400 r/min. For the rest, let's just say that Ford is climbing the Auto Charts and with good reason. Leaving aside a dash layout that the more sensitive among us might regard as a little glitzy, the Focus exudes a feeling of solidity and refinement that feels positively Germanic.

● The 2015 Focus features a range of Green tech, from Auto-Start-Stop, Active Grille Shutter, EcoMode and smart regenerative battery charging. The six-speed manual transmission helps, too. But the company isn't resting there: it was reported earlier this year that Ford would be exploring a new type of cylinder deactivation. In partnership with the Schaeffler Group, a new dual mass flywheel was being tested that enabled cylinder deactivation to take place at a wider range of engine loads and speeds. Initial tests showed fuel efficiency improvements of up to 6 per cent. Price: R218 000. – AD

VOLVO XC90 D5

THE NEW COOL

I knew from the international launch that the new XC90 was a special car, but putting it to the test of carting my family around for a weekend really drove the point home. The car is assured on the road with the 2-litre turbodiesel never feeling under-powered. Build and fitment quality can rival even the very best and the material choices are a good combination of practical and luxurious. Most impressive, however, is the interior space. Even with one of the third row seats in use I could still fit a pram and a full month's groceries in the boot. My only irritation was the steady flow of interested people who came over to chat every time I parked in a public place. If you need a large SUV that can accommodate seven, will stand out in a crowd and feels like it's from the future, this is the car you get. Price as tested: R920 000 – LS.



~~CARS~~ TOYS



LEGO TECHNIC MERCEDES-BENZ AROCS 3245 TIPPER

CHIP OFF THE OLD BLOCK

The Unimog Lego clearly struck a chord. Its follow-up is described as one of the most complex models in Lego's Technic range – its designers even went along to the truck production line to get a closer look. The Arocs 3245 stands 31 cm high, 14 wide and 54 long and consists of 2 793 separate parts, with battery-operated power functions to drive the model's "pneumatic" components. Detail work includes the bucket-tooth design of the radiator grille, the handrail, steps, and plenty more.

Go on, you know you need one. It's available at retailers and selected M-B dealers. **PM**

HOW TO GET STARTED IN...

BY ALEXANDER GEORGE

BICYCLE COMMUTING

South Africa may lag behind, but Cape Town is leading the field in terms of bicycle friendliness and Johannesburg is edging towards 1% of commuting traffic by bicycle. If getting fit and saving money sound appealing, here's how to do it right.



Pick your bike

► THE ROUTE

Before you buy a bike, you need to know your route. Go to Google Maps and your city's official website to locate bike lanes. Better, find bicycle-only pathways. Besides avoiding cars altogether, you can keep momentum, which means less energy spent stopping and starting.

With your route chosen, drive it to see how many hills you'll need to climb and to get an idea of mileage. This will affect the type of bike you choose. If you're like the majority of commuters in this country and will be riding 15 km or less to work, a hybrid or gravel bike is the best option. These have the light frames and narrow tyres that make road bikes fast, but with relaxed geometry to keep you comfortable.

► THE PURCHASE

Avoid shopping online. Instead, buy from a local bike shop with a good reputation. Not only will they make sure you get a proper fit but usually there are perks, like the ability to swap out parts, and free tune-ups later. Plan to spend at least R5 000, and add components as needed. In Cape Town, disc brakes and fenders will help you stop when it's wet and keep mud off your clothes. In Jozi those parts are just extra weight.

THE CHECKLIST: ARE YOU READY TO START BIKE COMMUTING? All must apply.



You know how to ride a bike.



You are not averse to moderate exercise.



You won't brag about saving the world.



You will adhere to bike laws – most of the time.



You are prepared to slap a car bonnet if need be.



You don't care what a bike helmet will do to your hair.

► THE ULTIMATE COMMUTER BIKE:

Trek 7.2 FX

Wildly popular because of the smooth-riding steel fork and quality Shimano drivetrain. The 7.2 FX also comes with Bontrager H2 Hard-Case Lite tyres that'll resist punctures and last for hundreds of kilometres when properly inflated. The frame is set up to be a canvas for add-ons like fenders and a rear rack, the latter of which we highly recommend for any commuter. Also, at about 13kg, the bike is light enough to carry up stairs.

Enquire at dhbdistribution.co.za



WHAT ABOUT . . .

Folding bikes?

Great for city dwellers, these collapse small enough to fit in a taxi trunk or under your table at a café. The small wheels and foldable frame mean you lose comfort and speed, but companies like Tern and Dahon engineer for increased torque and rigidity.

E-bikes?

The on-board batteries that give electric bikes extra pedaling power make them heavy and expensive. Best for hilly routes or to avoid sweating. **Important:** Make sure you have adequate access to a plug point at work and at home.

Bike sharing?

Only really feasible when travelling to different cities. There are bike-sharing programmes where you check bikes in and out of stations at a monthly fee, but these are hyper localised, so probably not the best option right now in South Africa.



Gear up

► THE ESSENTIALS

Helmet: More than half of bicycle-related hospitalisations and deaths are due to head injuries, so wearing a helmet isn't optional. Find one with CPSC certification. We like the Giro Savant MIPS, which is layered so that the shell and interior lining shift around the head when struck, diffusing the impact.



Lights: Don't skimp here, either – cheap lights don't have enough lumens to be visible at a long distance and aren't as reliable or durable. The weatherproof Cygolite Metro 400/Hotshot 2W combo pack has 4 watts for the headlight and 2 for the taillight, so you'll be easy to spot.



► INVEST IN GOOD PANTS

Wearing regular pants, which don't stretch, forces your legs to work harder, and regular tailoring will be tight around your quads. There are all kinds of cycling pants, but some companies now use just enough polyester to let your legs move freely while still providing the look of classic trousers. We like Woolworths Country Road Twill pants because the twill weave is stronger, more flexible and inherently stain resistant (due to the over-under weave). They're a huge upgrade in comfort, and your colleagues will have no idea.



► DON'T GO MESSENGER

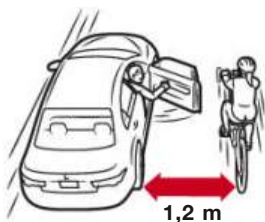
Unless you need quick access to your stuff while riding, forgo a messenger bag for a pannier, which attaches to a bike's rear rack without blocking the taillight. Even messenger bags and backpacks designed with space for airflow across your back leave you sweaty where the shoulder straps fall. They also have less interior space and will tire you out faster. Panniers like those from Thule have a full clip to securely attach to the rack (regular hooks can get dislodged on bumpy roads) and are waterproof.

3

Survive the commute

BEST PRACTICES FOR RIDING IN TRAFFIC

Even though bike lanes are being added to cities around SA, cars are still very much a part of the equation. Here's how to coexist.



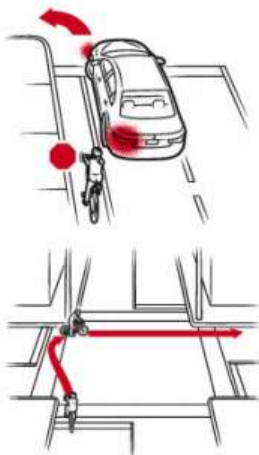
► POSITIONING

In a bike lane or on the road, keep as much distance between you and parked cars as possible. Getting "doored" is a common accident that happens when a driver-side door opens unexpectedly. Riding more slowly and staying alert will help you avoid this.



► MERGING WITH TRAFFIC

If there's something blocking your path, signal with your arm, wait for cars to pass, and merge into traffic like a car. If there is no bike lane, riding in the traffic flow, not to the left, is ideal and sometimes even the law. It makes you more visible and less likely to get hit.



► NEGOTIATING INTERSECTIONS, TWO WAYS

1. If you're to the left of the cars, stay behind the first car, even if you're on the side in a bike lane. This will help you avoid getting "hooked" by a car's unexpected left turn. When possible, bike in the traffic stream.

2. When a right-hand turn looks dangerous, cross the intersection, then stop at the far-left kerb. When the light changes, cross the street like a pedestrian.

BIKE TO A MEETING – WITHOUT GETTING FIRED

Don't let work attire stop you from commuting.

1. Leave yourself extra time. Besides getting an opportunity to cool down after arriving, you can pace yourself and sweat less, coasting as often as possible.

2. Wear an undershirt, ideally made of at least 90 per cent merino wool. Natural fibres breathe better than gym-ready synthetics, which will keep your skin dry but can hold on to bad odours. While riding, unbutton your shirt Hasselhoff-style for ventilation.

3. White, navy, black and patterns hide sweat stains. Bright blues and grey show them. If you're worried about odour and don't have a shower at work, hand sanitiser under your arms works in a pinch. Seriously.

4. Fold your blazer inside out and stash it in your pannier like so: ►



4

Secure your bike



► HOW TO PROPERLY LOCK YOUR BIKE

No lock will survive a determined and well-equipped criminal, but the proper equipment and locking technique mean a thief will pass your bike over for one that looks a little easier to steal. Start with a serious U-lock such as Kryptonite's New York Lock Standard, which will withstand wire cutters and grinders, but is more manageable than heavy chains. Then supplement the U-lock with a cable lock (pictured above) to protect your wheels. If you're locking up in a sketchy area, Pinhead makes locks that require keys for seats and quick-release wheels, which are both easy to steal.

TIP! BEWARE THE SUCKER POLE

Securing your bike to a structure that can be disassembled makes locking up moot. Avoid bait poles that have ground bolts already removed by bike thieves and rickety construction scaffolding.

ILLUSTRATIONS BY JAMES PROVOST (TRAFFIC)

5

Maintain your bike

► DAILY

Checking the tyre pressure every few days will save you from flats caused by under-inflation. Use a floor pump, and keep the pressure within 70 kPa of the number written on the sidewall of the tyre. If the tyre feels squishy, add air.

► MONTHLY

Lubricate the chain with climate-specific bike lubricant (twice a month in wet weather). With the bike upside down, hold a rag against the chain while turning the pedals. Lightly apply lubricant onto the chain. Wipe off excess.

► YEARLY

If you ride regularly, have your bike shop do an annual tune-up. Replacing parts like brake cables is tricky, and fixing skipping gears or misaligned wheels requires special tools. Improperly re-assembling these parts can ruin the bearings.



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150 years

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1 of 4 Bosch hampers worth R10 186 each

Each Bosch Hamper contains: a **PBD 40 Bench Drill**, a **PCM 1800 SD Dual Bevel Sliding Mitre Saw**, a **PHO 2000 Planer** and a **PST 900 PEL Jigsaw**.

The **PCM 1800 SD Dual Bevel Sliding Mitre Saw** has a 1 800-watt motor, dual bevel mechanism and 254 mm blade making the **PCM 1800 SD** ideal for high-capacity cross cutting, bevel cutting, mitre and double mitre cutting through wood and aluminium.

The **PHO 2000** has a patented Woodrazor blade system ensuring an even, smooth surface and the 3 V-grooves allow convenient chamfering. An intelligent blade system makes changing of the planing knife a breeze.

The **PST 900 PEL** has a powerful 620 W motor, accelerator function, integrated setting wheel for the stroke rate preselection and a pendulum action switch enabling precision work in all materials. Plus, CutControl and the integrated PowerLight accurately track the cutting line.

The **PBD 40 Bench Drill** has a two-speed electronic speed/torque setting, laser function and LED display of drill depth and speed ensuring precision drilling, with a chuck clamping range of 1,5 mm to 13 mm, maximum drill stroke of 90 mm and capacity of 13 mm in steel and 40 mm in wood.



To enter, answer the following question:
Which Bosch power tool features 3 V-grooves?

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SKILLS

INSIDE

● PROJECT: STAND-UP PADDLEBOARD ● SHOP NOTES ● PROJECT: RETRO SCOOTER
● DIY CHALLENGE ● TAKEN APART: OUTBOARD MOTOR



Justin McMillan, owner and manager at Journeys of St George Island in the Florida Panhandle, takes the author's new board for a test ride.

HOW TO MAKE ANYTHING

STEP-BY-STEP STAND-UP PADDLEBOARD

Waves or no waves, here's one sure way to get you to walk on water.

BY BUCKY MCMAHON



There was a time, and a very fun time it was, when surfboard design was the most important thing in my world. I happened to be the perfect age, a surf-crazed 13, during the short-board revolution, when surfboards changed from clunky behemoths to nifty little rockets. And lucky me, I was also the perfect age, a sports-battered 50, when the stand-up paddleboard pulled into port. With the SUP, that crucial and gruelling transition from belly to feet is eliminated at a stroke. And there's something about catching a wave while standing up that's uncannily exciting. You can ride them on lakes and rivers as well.

But for all my enthusiasm, I didn't think I could make any surfboard, let alone a SUP, which is a surfboard writ large. I did just enough research to be intimidated by dozens of detailed steps. And then I had the opposite thought, which was that if it floated, it would surf. So, chill. Besides, there are really just two steps: shaping and laminating. Rub it some and slap on goo. The rest, as they say, is ding repair.

SHAPING

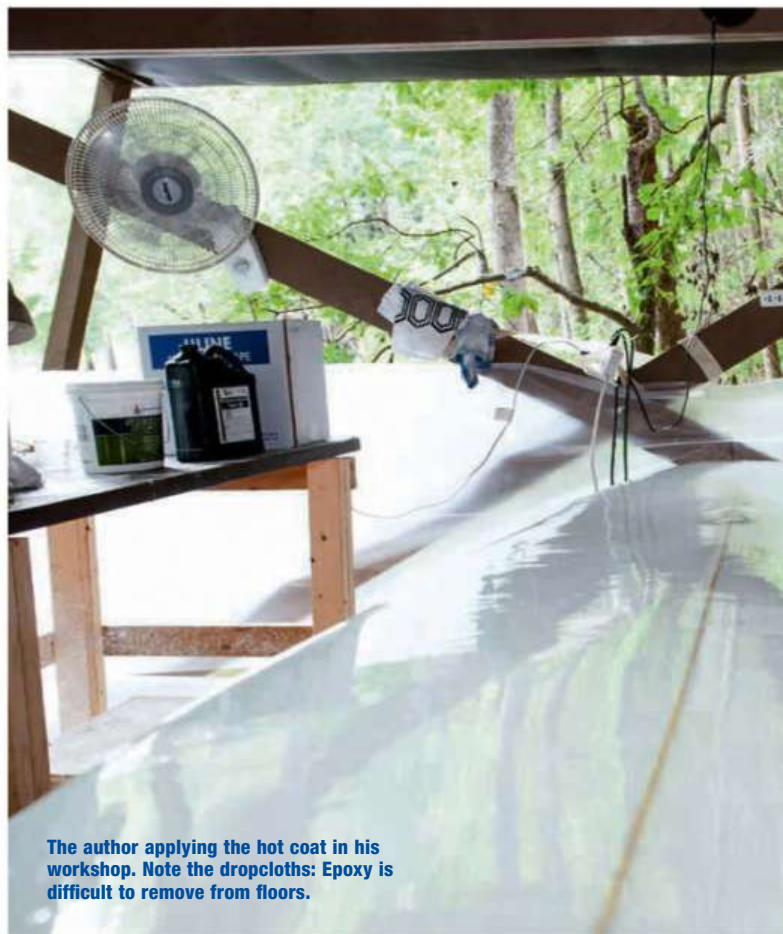
At a surfboard-makers supply store, I bought a SUP blank – a 315-centimetre rectangular slab of expanded polystyrene (EPS) foam with a strip of basswood known as the stringer running through the centre. You can also purchase one of these online. Be aware: EPS requires epoxy resin, because polyurethane resin will melt it. (This is important!)

I trucked that blank home and stared at it. It already had a rocker, which is a gradual curve from nose to tail, like the upturn in a boat's prow. A rocker keeps the nose from burying itself in the water while you're riding and also lifts the front of the board under wave power. I could adjust for more or less rocker as I shaped. But first I had to do the rough cut, which you can do with just about any kind of handsaw and a template, much like cutting cloth with a pattern. For my template, I traced a borrowed 3-metre SUP on 12-kilogram roofing felt with a white pencil. I traced half a SUP lengthwise, I should say, with the machined edge of the felt to be lined up with the blank's stringer. By tracing a hemisphere and doubling it by flipping it, you are assured of symmetry.

With a very sharp 250-millimetre pull saw, I followed my outline, making a few cuts from the outside edge to the cut line to free up the saw in the curves – a scissoring trick learnt in kindergarten. Mostly I was in awe of the saw and its silent, near effortless progress through the buttery-smooth EPS foam.

I could've taken that rough cut, rounded the edges, and had a perfectly functional SUP shape for flat water. It would've surfed too. But I was more ambitious than that. I wanted to take about 25 millimetres off the deck – the top part where you stand – doming it gracefully down to perfectly rounded rails (the sides) for smooth turning. I wanted high functionality: speed, control and manoeuvrability. I wanted to shape.

Hand-shape, I should specify, unaided by expensive power tools. I picked up the saw again, marking it with tape at 20 millimetres, and made numerous vertical cuts in the deck to that depth. I had measured and marked the rails for desired thickness (114 millimetres at the thickest point) and made sure to leave at least 12 millimetres of foam above the marks. Then I cut in horizontally from the rails to the stringer, lifting off slabs of foam I wouldn't have to shave off later. Essentially, I used the pull saw to do the job of an expensive power planer. I carved that baby like a standing rib roast, and when I was



The author applying the hot coat in his workshop. Note the dropcloths: Epoxy is difficult to remove from floors.

done I thought, oh my God, what have I done? It didn't look pretty. But I had not yet, I reassured myself, trespassed into the ideal board that still existed inside that angular debris field.

Somewhat dubiously, I moved on to the next tool – a 350-millimetre 50-grit drywall rasp. Within 15 minutes I was competent. After an hour I was in love. I was "mowing foam" (as shapers say) in long smooth strokes, albeit at a rate of maybe a quarter of a

MATERIALS

315 mm surfboard blank
Epoxy 3000 12 litre set (includes 8 litres resin and 4 litres hardener)
200 gsm 1 270 mm-wide glass fibre, 8 m
200 gsm 965 mm-wide glass fibre, 3 m
SUP handle (installed after shaping, before laminating)
SUP Gore-Tex vent (installed inside handle to allow EPS to off-gas)
Fin box (installed after laminating)
Fin
Leash cup (installed after laminating, for attaching leash to board)
Deck pad (glued to deck after laminating)



millimetre at a time. I put on some rock 'n' roll and went into a shaper's trance, alternating at times between the rasp and a palm-sized hand plane for the wooden stringer. I did some measuring along the way, but not a lot. A surfboard is essentially a spear point for cutting through water, and I believe we all possess a deeply atavistic knowledge of honing such things.

Following up with a lighter sanding block with an 80-grit screen, I polished the foam to an admirable sheen, smooth as a baby's behind. And I stuck a handle on the side with epoxy.

LAMINATING

In the real world the shaper and the glasser aren't usually the same person. The shaper is the rock star, the thinker, the artiste. The glasser is the technician, the dude with the job you don't want. You can shape at leisure, but once you pour hardener into your resin the clock is ticking. You want to work quickly but not frantically. Good luck!

Before mixing my first pour of epoxy resin and hardener (in a 2:1 ratio), I watched a lot of instructional YouTube, so much so that I was undeniably procrastinating. In the end, your first glass job is a baptism by liquid fire. I survived. My SUP survived. But it was a close thing, at times a bit harrowing.

A STEP-BY-STEP GUIDE TO YOUR NEW PADDLEBOARD

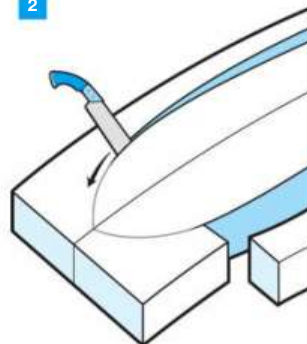
Building a paddleboard is simple in theory, but can be complicated in practice. These are the general steps, but plan to do some research on the shape you like and the tools you want to use before you get started.

1



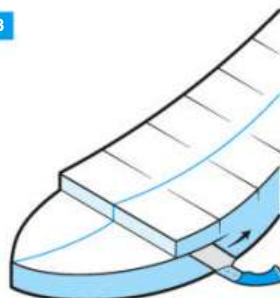
Trace half of a borrowed SUP or printed template onto roofing felt. You'll flip the felt when you transfer the shape onto the foam.

2



After drawing the shape on the foam, use a 250-millimetre pull saw to cut around the outline. You may need to cut in from the sides to free up the saw.

3



To remove bulk in advance of hand shaping, make 20-millimetre cuts into the foam from above, then saw them off horizontally, like a rib roast.

4



Hone the board into shape with a drywall rasp and a hand plane. It should look like a curved spear point, with no rough edges.

5



Cut out three pieces of glass fibre cloth – two for the top and one for the bottom. You may have to fold it at the corners to keep everything smooth.

6



Lay the glass fibre on the board, mix the epoxy, and pour the epoxy over the glass fibre. Spread the epoxy with the included tool.

The weight (thickness) of the glass fibre and the number of layers to be applied are known in the trade as the glass schedule. My schedule called for one layer of 200 gsm (6-ounce) glass fibre for the bottom and another two layers on the deck, where you need the most protection. Laminating is akin to tailoring: you lay out the glass on the board and cut so that it overhangs by about 75 millimetres and wraps around the underside in a snug fit. This requires darting to accommodate the curves.

You laminate the bottom of the board first, and if you're smart you'll masking-tape the entire deck to protect it from splashes. To laminate the deck, you cut one layer of glass fiber to fit (the easy cut) and then a second layer that goes on top of the first and overlaps by 75 millimetres (as with the bottom layer). Gently smooth them out by hand, from the centre to the tail, and from the centre to the nose, until there are no wrinkles. Then pour and spread epoxy over the two deck layers. Having done the bottom the day before, I was already more competent with the little plastic spreader tool. I spread the epoxy with long strokes, listening for a zinging sound that means the glass is fully saturated. Pull and bring the excess to the rails, and wrap the glass fibre underneath, catching drips in your mixing bucket, repouring excess epoxy where needed.

At lamination's end, to my relief, I found I was somehow well within the parameters of the acceptable. The good news is, if all goes mostly well, there's nothing you can't fix. Lumps can be sanded. Thin spots retouched with a small batch of resin. Ding repair, as I said. After the resin and glass fibre layers have dried completely, in 24 to 48 hours, both the bottom and the deck receive

another epoxy layer, called the hot coat.

This is also another opportunity to give the board a smooth, glossy finish. Finally, I installed the finishing touches: a leash cup to hold the leash, the fin box, and the fin on the bottom. I glued a deck pad to the deck over where I'd be standing.

My end result was surprisingly successful, admirably light, and nimble in the water.

The SUP passed its flat-water test with flying colours, floating a 90-kilogram test pilot. The surf test awaits.

But hurricane season is here, and when the next named storm rumbles up the Atlantic Coast, that SUP will ride the swells. I'm stoked.

HOW TO ADD FINS

A fin is a SUP's rudder, so it needs to be firmly attached. Fortunately, manufactured fin boxes, such as the 265-millimetre Fins Unlimited box I used, are simple to add. After lamination, trace the box on the bottom of the board about 175 millimetres in from the tail and centred over the stringer. A router will cut neatly and quickly through the glass fibre, foam, and wood stringer. To glue in the box, coat the bottom and sides of the slot with a small amount of epoxy, press in the box (wiping away excess resin), and hold firmly for a few minutes.

THE CROSSING

A very athletic office worker paddleboards his way to a personal triumph – and a piece of history.

BY JAKE JACOBY

It started off easy. I stepped onto my board at 6:42 am in calm waters just off Dionis Beach, on Nantucket, Massachusetts. The brisk wind that was building from the south immediately began to push me towards Cape Cod, about 40 kilometres away. I scanned the horizon for my escort boat.

My plan was to perform the first known crossing of Nantucket Sound by stand-up paddleboard. I had been waiting weeks for the right wind direction. A south wind would be at my back, helping to push me north towards my goal. It would also allow me to catch and ride (surf) the swells created by that wind, giving me even more speed (and fun) with less effort. In stand-up-paddle parlance this is known as a downwinder or a downwind run.

After months of planning, training and anticipation, it was time to shut up and start paddling. I was nervous, no question about it. Nantucket Sound is one wild stretch of water. Although its status as a sound implies that it is protected compared with the open ocean, all the name really does is provide a false sense of security to the unprepared. Heavy winds combined with shoals and strong tidal currents lead to waves travelling in multiple directions and colliding with one another. Nantucket Sound has claimed many shipwreck victims. Plus, great white sharks have been spotted in the sound off Cape Cod with regularity in recent years. While I knew my chances of being attacked by a shark in these waters were small, I did grow up in the *Jaws* generation. I kept thinking of the scene in which Chief Brody tells Quint, "You're gonna need a bigger boat."

I was also slightly concerned about my lack of training and experience. At the time of the crossing, I was a 41-year-old weekend warrior who spent the majority of my waking hours in an office. Family and work obligations had limited most of my training sessions to less than a quarter of the distance I was planning to cover. I was still recovering from four sports-related surgeries in the previous three years. And I had never paddled in the type of conditions I would soon be facing. The Nantucket crossing would push the limits of my experience, ability and stamina further than I'd ever been pushed before. But I wanted to test myself – and I really liked the idea of being first.

My safety escort boat finally appeared on the horizon. I began catching and riding the wind-driven swells, linking ride to ride in a way I hadn't experienced before. I would glide for 30 metres or so and then, as the swell passed me by, I would need only one or two strokes to catch the next one. It felt incredible. Ride, paddle-paddle, ride. I crossed the ferry path around kilometre 5 and continued to head north, regularly checking my course on my GPS watch.

As I moved farther away from Nantucket into less protected water, the wind began to strengthen and the swells grew. I stayed dry for the first hour and a half, but then had my first fall of the day. I climbed back on the board and sat for a minute with my legs in the water. It seemed like a good opportunity to eat some energy gel, grab a sip of water from my waist-mounted hydration pack, and take a quick rest. I realised I hadn't turned on the iPod Shuffle I was carrying in a waterproof bag. The music powered me through the next couple of hours: Johnny Cash, Bob Dylan, the Clash, the Grateful Dead. I did fall a few more times in that stretch, but each fall was a welcome opportunity to hydrate and take a quick rest. I passed the halfway point, and the



The board was getting whipped around by 30-km/h winds and shoulder-high swells. I just focused on staying upright.

swells were now between waist- and chest-high. The sea was also more confused, assaulting me from multiple angles. I couldn't see land in any direction.

Then, around kilometre 22, I felt my first muscle cramp. My upper abdominals began to seize as I climbed back onto the board after a fall. I was cramping with more than 15 kilometres to go. Had I been drinking enough fluids so far? Probably not, but it was too late for

that. I lay down on my stomach and stretched my abs by pushing up on my hands. The strategy worked, and the cramp released.

From there the conditions continued to deteriorate into the toughest I had ever paddled in. The wind was now cranking above 30 kilometres per hour, and some of the swells were shoulder-high and occasionally breaking with frothy white tops. The board was really getting whipped around. I was constantly thrown off balance,

which forced me to drive the paddle backward or sideways into the water to keep myself from falling. I became more focused on staying upright than on riding swells. I still caught a few, but the swells were so steep I had to take care not to bury the nose by shifting my weight backward on the board and trying to cut across the swells at an angle.

Around kilometre 29 my escorts pulled up and told me I was too far east. There were rocks all the way from Yarmouth to Chatham, so they wanted me to try to push back to the west, towards Hyannis. I said I would try. I gained a little ground but realised there was no way I was going to make it far enough west to land in Hyannis. I asked if there was a place I could land safely in Yarmouth instead. They said I would probably be okay – but that they wouldn't be able to follow me all the way in.

New doubts began to creep into my head: would I be able to see the rocks? Would the waves be breaking hard on to the beach? If so, how was I going to be able to get back out to the boat against this wind? Should I have them pick me up a kilometre short of the beach? After all, I would already have crossed the sound. This was just a question of safety and the ability to get over the final few hundred metres. I thought of mountaineers who are sometimes forced to turn away tantalisingly close to a summit. How devastating that must be.

But my plan had been to go shore to shore unaided. I had to try to make it all the way. If I got closer and it looked too sketchy, I would consider bailing.

Then Adam in the escort boat gave me some final words of encouragement: "You might want to keep a better eye out for sharks on this stretch. I think this is close to where some of the great white sightings have been." Uh-huh. I looked down at my feet. They were nicked up and bleeding. I must have cut them at some point while falling or climbing back on the board. Great whites can smell blood in the water from how far away? I admit to looking around nervously over the next couple of kilometres, but that faded as my goal neared. I was going to make it, and my adrenaline began to surge. I decided that my landing would be a public beach that I saw ahead. Over the last kilometre or so the water was only a couple of metres deep and the swells lay down a bit, so I was able to catch a few nice, superlong rides. There I was, flying over the water, the bottom clearly visible, covering more than a football field at a time without even having to paddle. A few metres from the beach I hopped off, pulled off my leash, and carried my board out of the water. I looked at my watch: It had been six hours and 16 minutes since I had stepped onto the board in Nantucket. I had travelled 39 and a half kilometres. A lifeguard came up and asked where I had come from. When I told him Nantucket, he was blown away. He offered me some water. I had landed on Seagull Beach in Yarmouth, less than a mile west of my original target.

People will make the same crossing faster, and some may do it with more style. But I will always be the first. Score one for the weekend warrior. **PM**

SKILLS THINGS COME APART

A PHOTOGRAPH
BY TODD MCLELLAN

DISASSEMBLY REPORT:

OUTBOARD MOTOR

MODEL: MERCURY MARINE 6 HP

NUMBER
OF PARTS:

501

PRODUCED:
KOMAGANE, JAPAN

TIME TO DISASSEMBLE:
9 HOURS, 20 MINUTES

NOTES: Outboard motors can be big, bolt-in-place monsters that produce more power than a sports car or, like this 26 kg Mercury Marine 6 HP model, smaller clamp-on powerplants with just enough juice to troll on a nice afternoon.

- 1 **CYLINDER HEAD:** As in your car, the cylinder head is where the spark plug plugs in. But this cylinder head also houses a thermostat. When the engine reaches a high enough temperature, the thermostat opens so cold water can enter and cool the motor.
- 2 **CAMSHAFT:** Operates the motor's valve system. As the camshaft turns, its cams push against rods (called pushrods, see?) that open valves on the cylinder to let fuel in and exhaust out.
- 3 **WATER-PUMP HOUSING:** The motor is cooled by water from around the boat, which is pumped along the driveshaft. The driveshaft also powers the water pump, so as the engine revs up, more water is pumped in.
- 4 **DRIVESHAFT:** The length of the drive-shaft you need is determined by the height of the transom on your boat. (Engines are much more effective when the propeller can reach the water.)

- 5 **PROPELLER:** A propeller is essentially a set of wings that rotate. The shape of an aeroplane's wing generates lift by manipulating air pressure. Similarly, a propeller's shape generates thrust by manipulating water pressure: acceleration is caused by an absence of pressure behind the blade. Water rushes in to equalise the pressure, propelling the boat forward. Also, if you want to fit in on the docks (or at least in the service areas), refer to the propeller as a screw.
- 6 **PROPELLER SHAFT:** This transfers the power created by the driveshaft to the propeller. A clutch slides along the propeller shaft, linking it to either the forward or reverse gear. As the shaft turns, it turns the propeller in the same direction.
- 7 **COWLING:** The cowling contains the motor and includes a carrying handle, since a motor this size can be easily carried around.

- 8 **FUEL TANK:** Holds enough fuel to run the motor at full throttle for one hour. If that isn't enough for your plans, the motor is pre-plumbed for adding an external fuel tank.
- 9 **CLAMP BRACKETS:** These attach the motor to the boat and adjust the trim – the angle between the propeller and the water. If the motor is trimmed out so that the propeller is further from the back of the boat, you get a higher top speed. Tuck it in towards the boat for faster acceleration.
- 10 **FLYWHEEL:** A four-stroke engine like this one delivers power on the third stroke. (The piston lowers on the intake stroke, compresses an air-and-fuel mixture on the second stroke, gathers power after the fuel is ignited on the third stroke, and pushes out exhaust on the fourth stroke.) But something has to help it get started. When you yank the starting cord, the flywheel rotates and its momentum helps the engine turn over (or run through the first few movements). If the motor is in gear, a little nub called a pawl blocks the flywheel from spinning so that you can start only in neutral.
- 11 **TILLER HANDLE:** Move the handle towards the port (left) side of the boat to steer to the starboard (right) and towards the starboard side to head to port. The grip operates the throttle. Two cables link it to the carburettor. A twist controls how much fuel goes to the engine.

– KEVIN DUPZYK

HOW MUCH HORSEPOWER DO YOU NEED TO . . .

Fish	0
Troll for fish	6
Run a pontoon boat	35
Pull a kid on an inner tube	60
Pull an adult on water skis	115
Pull a portly adult on water skis ..	150
Power your yacht	1 500



MITRE SAWS LOSE THEIR CORDS

Increased portability doesn't have to mean decreased performance.

By JOSEPH TRUINI and ROY BERENDSOHN

Cordless power tools are no longer, it seems, the weakening portable runts of the handyman's litter. As battery technology advances they're becoming increasingly powerful as well as being able to operate for longer. That's opened the door to cordless operation of bigger tools such as the mitre saws reviewed here.

Admittedly, you can't rush down to the nearest hardware store to buy most of these, but we're told that South African distributors are considering introducing them to the local market, which has certainly taken to battery-driven drills with enthusiasm – even for hardcore use by people who do this kind of thing for a living. (One of the things that needs to be taken into account, for instance, is the availability of chargers with a suitable voltage rating.)

Speaking of the pros, before we tested cordless mitre saws, we wondered if they were too specialised. Were they built just for pros who jump from job to job? The four we reviewed proved to be valuable for anyone who needs compact mobility. You can use them to set up a workstation in the same room as the project you're working on, or outside if you're building a patio or deck. That way you're not running back and forth to the garage for every cut. Using 25 x 100 pine rafters to stand in for expensive trim, we made nearly 1 200 test cuts and found that any of these machines do a day's work on one charge. Their batteries will run out long after yours do.



* The Makita XSL01Z sold in the US and featured here is a single-battery 18 V model. South Africa will be receiving a different model, the DLS714, in the first quarter of 2016. This uses two 18 V batteries, making it effectively a 36 V unit. Incidentally, Makita sells its Li-ion batteries and charger separately.

MAKITA XSL01Z LXT

★★★★★

VOLTAGE/
AMP-HOURS:
18-V/5-Ah

Crosscut capacity: 330 mm

Cuts per charge: 356

Likes: The Makita's low-speed, high-torque motor is extremely powerful. It pairs perfectly with the saw's 40-tooth blade and slide action. Between the motor and the saw's crosscut ability, you have a machine that can slice huge crown moulding or framing lumber.

Dislikes: A great saw, but it's expensive. The one we tested had the optional 5-Ah battery. All but the most demanding users will be fine using the standard 3-Ah batteries.



DEWALT DCS361

★★★★★

VOLTAGE/
AMP-HOURS:
20-V/4-Ah

Crosscut capacity: 213 mm

Cuts per charge: 249

Likes: This is a fine product for professionals or advanced hobbyists who can afford the premium for something industrial-grade. The DeWalt has power to spare and makes a cut that's nearly mirror-smooth. It operates flawlessly with dead-on accuracy. And it's built like a tank.

Dislikes: It's not exactly a big deal, but we expected it to make more cuts per charge.



CRAFTSMAN BT2010

★★★★★

VOLTAGE/
AMP-HOURS:
19,2-V/4-Ah

Crosscut capacity: 116 mm

Cuts per charge: 272

Likes: The Craftsman and Ryobi are twins separated at birth. Almost everything said about one applies to the other. This is a lightweight, fast-cutting saw with excellent fit and finish and a small footprint.

Dislikes: We're nitpicking, but the indented area that holds the table insert could use a bevelled edge to keep wood from catching on it.



RYOBI P551

★★★★★

VOLTAGE/
AMP-HOURS:
18-V/4-Ah

Crosscut capacity: 116 mm

Cuts per charge: 300

Likes: As with the Craftsman, a good, fast-cutting saw with excellent quality of construction. It's handy, lightweight, and has a small footprint. The main difference is that Ryobi throws in an adjustable laser line to better align your cuts.

Dislikes: Like the Craftsman, it would also benefit from a bevelled edge on the table insert.

SHOP NOTES

Easy ways to do hard things



We are always looking for clever solutions to everyday problems. Email your shop notes to popularmechanics@ramsaymedia.co.za



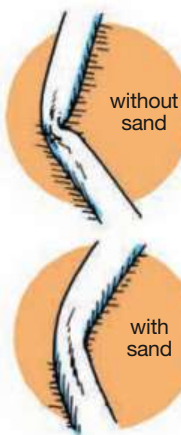
A COMMON CLOTHES IRON REPAIRS UNSIGHTLY DENTS

DROPPING A HEAVY TOOL on good timber can leave a nasty dent. To fix it, drip some water on the dent and let the wood soak it up. Place a shirt over the damp area and use a clothes iron on its medium-high setting to apply heat. The wood will swell with the moisture. Repeat until the dent is gone. Sand smooth. Note: does not work for heavy tools dropped on toes.



Bend PVC pipe into shape without breaking it

Phil Crockett of the Phil Crockett YouTube channel found an easy way to bend PVC pipe without kinking or breaking it. Use duct tape to seal one end. Fill the pipe with sand. Heat with a hair dryer until the pipe is pliable, then bend as desired. The sand keeps kinks out – the pipe cools with a nice, smooth bend.



SAWDUST THREE WAYS

Uses for sawdust, in ascending order of granularity.



COARSE

After a spill in the workshop or garage – think: pool of motor oil – a sprinkling of sawdust will absorb the liquid and aid cleanup.



MEDIUM

Rub hands with sawdust to remove grease. And exfoliate.



FINE

To create wood filler, mix sawdust with two-part epoxy.

HAMMERING NAILS IN TRICKY SPOTS

Sometimes a nail needs to go where it's difficult to hold it. In such a place, put a small ball of putty on the wall. Stick the point of the nail into the putty, which holds it. Hammer away.

To fix a door that sticks

First determine where the door is contacting the jamb: turn on the lights on one side of the door. Leave the other side dark. Standing on the dark side, note the light that outlines the door. The door sticks where the light is blocked. For a severe stick, remove the door and shave with a planer. For a non-severe stick, keep the door in place and use a paint scraper to relieve the doorjamb.



To still a door that always swings shut

Add friction to one of the door's hinges: Remove a hinge pin. Lay it on the floor and tap it with a hammer until it develops a minor bend. Put it back in the hinge.



Stiff bristles store sharp points

Constantly reaching for the same small tools? Stashing them point down in the bristles of an overturned scrub brush keeps tools handy and hands safe. Works best if files have handles on them.

UNPLUGGED

Workshop challenge No 3: do it, as far as possible, using only hand tools



So that's it, then. When the load gets shed, POPULAR MECHANICS readers take a nap, open a book, head for the mall equipped with a generator... anything but work on a project, it seems.

Workshop Challenge No. 3 was based on load shedding. Its initial premise revolved around filling the downtime – typically two-and-a-half hours – when Eskom pulls the big switch and the lights go out. We required that entrants, as far as possible, use no AC mains power directly to design and build their project. Battery-operated rechargeable tools were fine, as were hand tools, of course. Extra brownie points would be scored for a project that could be completed in the allotted time, that used no AC mains power *anywhere* in its timeline (including production of the raw materials) and that mitigated the effects of load shedding.

It looked straightforward, but clearly proved to be a tough ask for our home handypersons.

Eventually, it came down to two projects aimed at children. One was genuinely ingenious and used a good variety of tools. The other was disarmingly simple yet had the potential of entertaining growing minds and being capable of being used for other educational play activities besides its original intended purpose.

So, eventually, we picked the entry from Louis Barr of Cape Town as our winner.

Louis, an avid DIYer, kept it just about as simple as it gets, with the twin goals of finishing the job within the allotted time and keeping with the hand tool theme.

His educational toy starts with two 1,8 metre lengths of PAR pine timber. One was nominally 100 x 25 mm, and the other nominally 75 x 25 mm. The other raw material required was a length of 10 mm dowel. You can make an optional template, but this is not a requirement.

A base for the toy was made by cutting a 540 mm length from the 100 x 25 mm timber. This base was drilled 15 times using a 10 mm bit, the holes in 5 groupings, as can be seen in the attached photo. (In case you are wondering, he used a cordless drill.)

Into each of these holes a length of 10 mm dowel was inserted.

Fifteen 75 mm lengths were cut from the 75 x 25 mm timber, resulting in fifteen 75 x 75 mm squares, each 20 mm thick.

If this sounds all too easy, you will find out if you are careless with your alignment that things don't fit together at all easily towards the end. Bear in mind that a toddler will need to be able to manipulate the blocks.

"Accurate measurements, cutting and drilling are required. That's why I made a jig/template to help," Louis says. "I made a drilling template from a piece of Perspex, for a maximum of five holes per block and marked the blocks in the typical domino or die pattern." That is, one block had one central hole, two blocks had two holes on the diagonal, three blocks had three holes, four blocks had four holes and five blocks had five holes). He then drilled the necessary 12 mm holes in all the blocks.

"For the first block, I placed the template on the block and

ORIGINAL PINE LENGTHS:

A 100 x 25 x 1 800

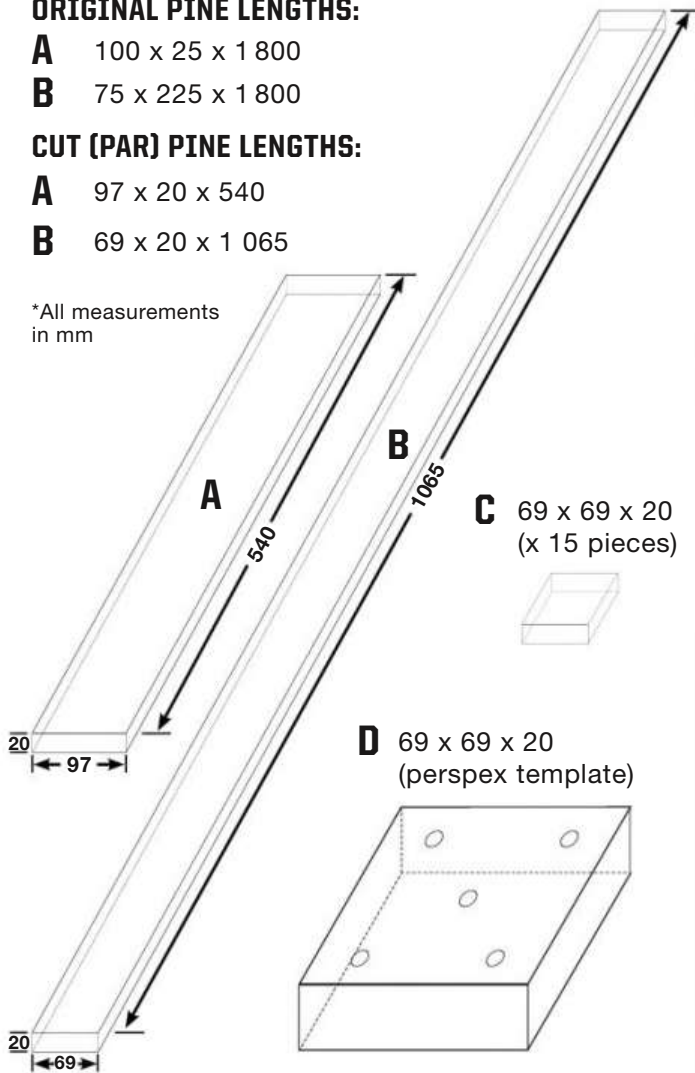
B 75 x 225 x 1 800

CUT (PAR) PINE LENGTHS:

A 97 x 20 x 540

B 69 x 20 x 1 065

*All measurements
in mm



drilled the centre hole," he says. "Each succeeding block simply had one extra hole drilled."

Tools used were the previously mentioned cordless hand drill, a tenon saw, a rasp and round files. "Lots of sandpaper" was required to smooth out the holes and round the sharp edges, as well as the tops of the dowels.

The challenge was completed – just! – in the allotted time.

"This educational toy will skill children, both from a visual and numeric perspective, as they match the blocks to the dowels, and count the blocks on each dowel grouping," Louis explains. In addition to that, tomorrow's construction engineers will no doubt find a way of turning the thing into castle fortifications and the like.

For his efforts, Louis wins a Makita Cordless Circular Saw hamper, valued at R8 000. Included in the prize are a Makita DHS710 circular saw, two 3,0 Ah Makita lithium-ion batteries (BL1830, with a recharge time of 22 minutes per battery) and a Makita compact fast charger DC18RC.

We're sure that our winner will appreciate his prize's ability to keep going when the power goes down – particularly given the amount of cuts he had to make with his tenon saw in completing this project within the roughly 150 minutes at his disposal...

AND ANNOUNCING:

Workshop Challenge No. 4

Accept the **PM Home Workshop Challenge** and a **Makita DHP458ZK Cordless 18V Lithium-Ion Impact Drill Kit**, valued at **R6 386**, could be yours.

THE THEME: IN THE GARDEN

Summertime and the living is easy. And a lot of the time it's outdoors. Whether your garden is the green leafy kind or the austere Oriental kind, there's bound to be a way it can be enhanced with your own efforts. We're thinking daybed, brick braai, water feature, treetop deck, unusual planter, labour-saving device... with just one condition. Unlike Challenge No. 3, this time around you are required to creatively use at least one power tool in putting together your project. Your scope is as wide as the imagination allows.

THE PRIZE:



Makita DHP458ZK Cordless 18V Lithium-Ion Impact Driver Drill Kit.

This top-of-the-range Makita 13mm impact driver drill features a battery indicator that displays the remaining battery charge; twin LED lights that illuminate when the trigger is pressed and 3 functions – drilling, hammer action and screw driving. The **DHP458ZK** provides plenty of power for those demanding tasks, with 21 torque settings to choose from – giving you perfect control and a maximum torque of up to 91 N.m.

This model is extremely compact in size with a 2 speed metal gear-box and steel keyless chuck. It features a rubberised grip, an extended side handle for greater control, a reversible belt clip for both left- and right-handed operation and a twin bit holder.

Included in the prize are a **Makita DHP458ZK impact driver drill** (supplied in a handy **carry case**) with **2 x 4.0Ah Makita Lithium Ion batteries** (BL1840 which recharge in 36 minutes) and a **Makita compact fast charger** (DC18RC).

To find out more, visit www.makita.co.za, like Makita on Facebook **Makita-PowerToolsSA** or call 011 878 2600.

Your project will appear in a future issue of **POPULAR MECHANICS**.

Email your plans and a picture of the results to popularmechanics@ramsaymedia.co.za by 13 January, 2016.

For full competition rules, see www.popularmechanics.co.za/workshopchallenge

Makita Popular Mechanics



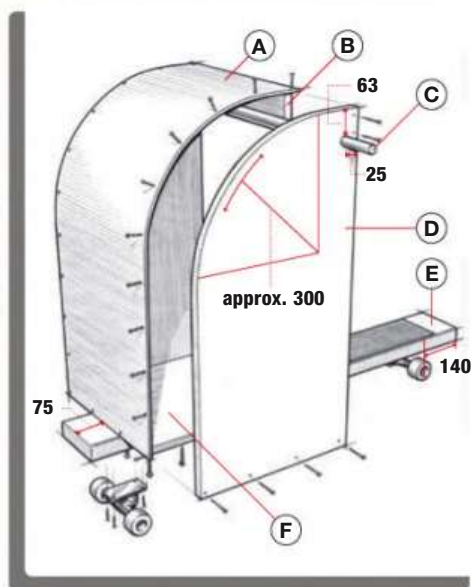
OLD-SCHOOL SCOOTER!

A project to build with your children.

DIFFICULTY:	EASY REASONABLE HARD		
	<div style="width: 60%;"></div>		
TIME: 1 hour	AGE: 12+		

PROJECT NOTES

WE WANTED TO RE-CREATE a classic scooter design with a built-in cargo area but with a base of thicker timber, sturdier fasteners, and a better handle made from a 20-millimetre-diameter dowel. The most significant change is our use of skateboard trucks for the wheels, greatly cutting rolling resistance and improving manoeuvrability. We added stability to the cargo box by running the dowel the entire way through the structure and by placing a 150-millimetre brace across the back. One other thing to keep in mind: You need a smooth curve on the side panels to prevent the lauan plywood front from cracking. Test-bend the lauan first, and soften the curve if necessary. We built this scooter to fit a child up to about ten to 12 years old. Tinker with the dimensions, though, and you could easily make this suitable for a younger kid. Or even an adult, if you're feeling nostalgic.



Our builder, Sal Castellano, is a participant in the FIRST Robotics Competition, a tournament that encourages kids to pursue careers in engineering and technology.

Shopping list

QTY	DESCRIPTION
1	50 x 150 x 2 400 pine
1	6 x 1 200 x 2 400 meranti plywood
1	20 x 1 200 x 2 400 pine plywood
8	6 x 150 lag screws
1	box 50 mm No. 6 wood screws
1	box 30 mm No. 6 wood screws
1	grip tape,* standard 225 x 840 size
2	skateboard trucks and wheels*
1	20 x 900 mm birch dowel

*Available at skate shops

Materials

QTY	DESCRIPTION
A	6 x 395 x 1 120 meranti plywood (front panel)*
B	20 x 150 x 356 pine plywood (crossbrace)
C	20 x 597 dowel (handle)
D	20 x 388 x 750 pine plywood (side panels)
E	50 x 150 x 1 145 pine (skateboard)
F	20 x 355 x 388 pine plywood

* Fasten to sides, then cut off excess length.

Instructions

parent only
parent and kid
kid only

1. Crosscut the 50 x 150 to make the skateboard (E). Round the front edges and sand the corners.
2. Centre and fasten the trucks with four 30-millimetre wood screws.
3. Trim grip tape to a 150-millimetre width and apply to the top of the board.
4. Use a track saw or a circular saw and straightedge to cut out the rectangles for the panels (D), the crossbrace (B), and the bottom of the cargo box (F).
5. To finish the panels, mark the curved front edge, then cut the curve on each side with a jigsaw and a narrow curve-cutting blade. Use a 20-millimetre holesaw to bore the handle hole through both sides.
6. To assemble the cargo box, drive 50-millimetre wood screws through each side and into the bottom panel. Put the crossbrace (B) in position and hold it with a pipe clamp across the box, then screw through the sides into

HOW TO MAKE ANYTHING



the brace. Glue and screw the curved meranti front to the cargo box, then cut off the excess.

7. Crosscut the dowel to length and use a mallet to gently drive it through the handle holes. Bore a 2,5-millimetre pilot hole through the back edge of each side of the box, then drive

30-millimetre wood screws into the handle.

8. Clamp the box in position on the skateboard and bore a series of 5-millimetre pilot holes up through the skateboard into the box bottom. Attach the board to the box with eight lag screws.

SKILLS ASK ROY

POPULAR MECHANICS' senior home editor solves your most pressing problems.

BY ROY BERENDSOHN



Q Our kids smashed an insulated-glass window playing baseball. The outside pane is broken, and the inside pane has a small crack. Can we replace just the insulated glass, or do we need to get a new window?

A Unlike single-pane windows, which secure glass with an easily replaceable putty, double-paned windows are more complicated. You shouldn't try repairing them yourself. Hardware store owner John Waslenko says that you can easily damage the sash trying to fix the glass. Once that happens, there's nothing he can do. You'll need a new window.

The good news is that removing the sash and bringing it in for repair is relatively easy. Most double-hung windows tilt out. Undo the thumb latches and tilt the sash into the clean position. Tip one of the free corners down while lifting the opposite corner (the one still in the window frame) up. Some wood-insulated windows lift out in a similar way, while others require a screwdriver to

unsnap a clip between the jamb and the sash.

The shop will remove the stops that hold the insulated glass. If the window is wood, the stops are usually thin wood strips held with brads driven into the sash. If the window is vinyl, the stops will be vinyl strips with a lip that fits into a groove in the sash. If you have wood windows that are more than 20 years old, they often have no stops. The insulated glass is held in place by the sash itself, which is nailed together. With these windows, the shop has to dig out the putty over the nail-head, remove the nail, and disassemble the sash. Next, the shop will cut away the caulk the insulated glass is embedded in. Finally, it will take the new insulated-glass unit, embed it in new caulk, and reassemble the window. This job

can take as little as a few hours to a couple days, depending on the parts that need to be ordered.

Q We painted our house last year, and I recently noticed a big water-filled blister on the side of it. What did we do wrong?

A The problem isn't the paint but moisture. It can come from a roof leak, a plumbing leak, an unvented and heavily used bathroom, or a small, poorly ventilated kitchen. As the sun beats down on the house, excess moisture caused by any of these issues seeps through the wall to the outside. When you had your old paint, much of its damage was probably caused by this moisture. The paint became so porous that water vapour could pass right through. A couple coats of new paint, however, can trap this vapour and form a blister. When the vapour cools, it condenses into water and remains inside the bubble. To solve the problem, you need to find the source of the moisture, then fix it by adding ventilation or sealing the leak.

Q My two-storey garage is built on a steep hill. The back gutter gets clogged with pine needles, and it's too high for me to clean easily or safely. Can I just remove the gutter?

A Gutters are very useful. They handle roof runoff in an orderly manner, preventing excessive splash-back against siding, and soil erosion and soggy conditions next to the foundation. I don't think you'd experience the soggy conditions, because the water runs downhill, but you would see splash-back and erosion from the impact of the runoff falling two stories. Instead of removing the gutter, try Gutter Helmet, an attractive metal cover that blocks debris yet allows runoff to flow freely into the gutter.



IS POWER THE SAME AS ELECTRICITY?

Nope. Electricity is a type of energy, just like wind or solar, and it's measured in amps and volts. Power is the rate at which energy is transferred, measured in watts (joules/sec). For example, an engine is powerful if it quickly converts chemical energy in fuel to mechanical energy. When the TV suddenly cuts off, it's because the electricity went out, not the power. Either that or your wife has the remote and is gently reminding you to get to work on the garden, like you promised.

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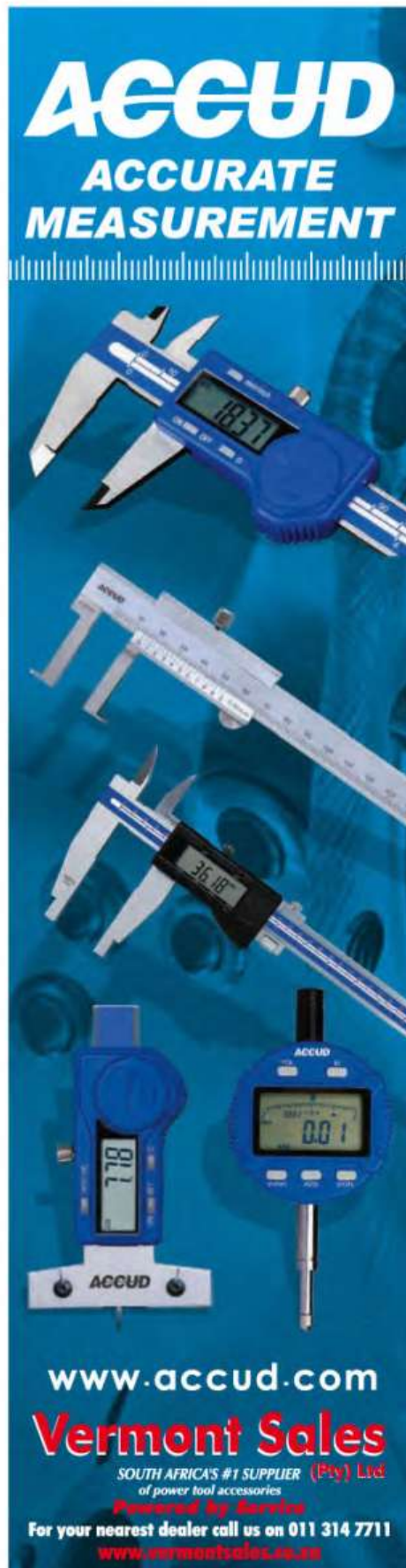
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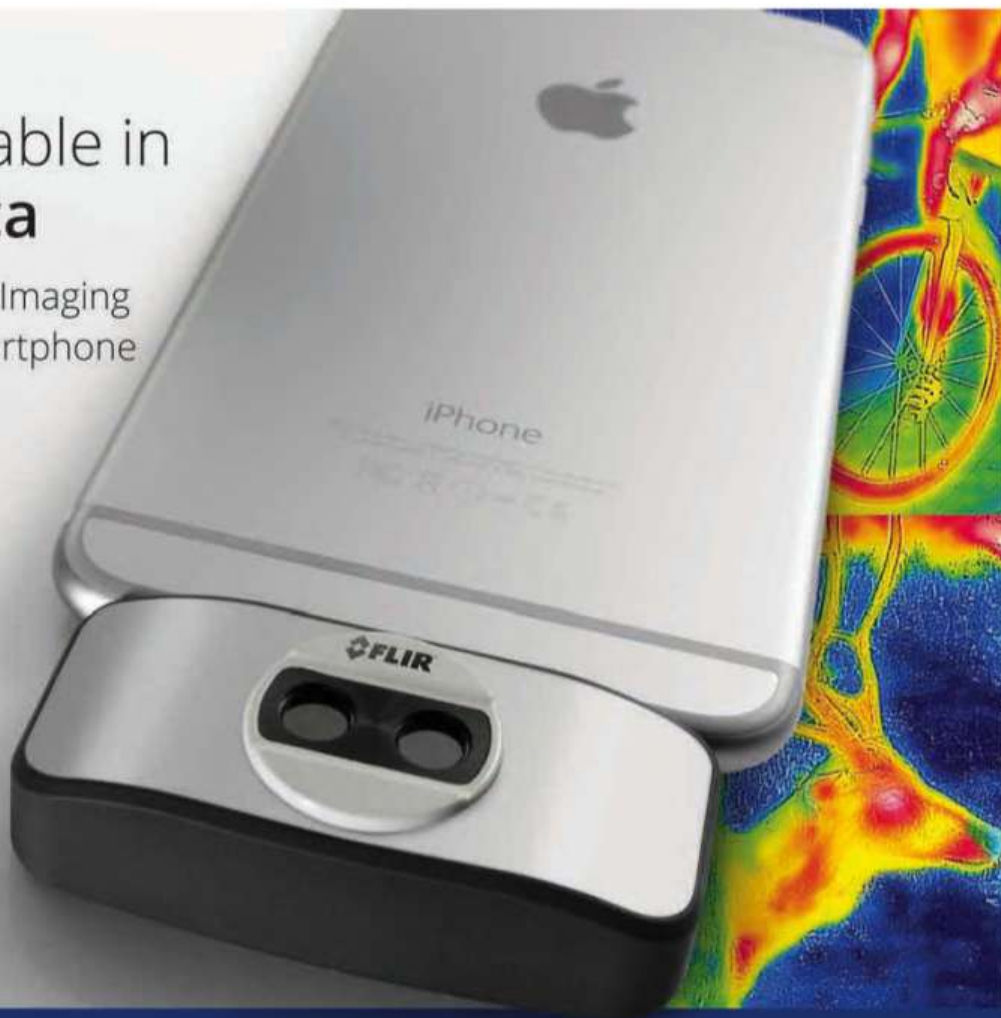
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X-Treme Vision from R295set



Xenon HID Headlight Kits
H1, H7, H3 & H4 from R495set
Philips HID Kits Now Available
from R1195set



Carbon Shields
Bonnet Guard - R320
Headlight Shields - R240
Windshields - R190set



Assorted DRL Style LED Headlights from R1395set



Lamin-X Films 60x30cm
Assorted Colors - R225ea
Custom Sizes can be cut



Auto Gauge
Assorted Design Autogauge
Performance Gauges
Boost Gauge - from R180
Oil Pressure - from R180
Oil Temp - from R180
Tachmetres, Shiftlights
and many more available



Ford Ranger Grilles, Spots
Arches, Snorkel Kits
& More Available



Non Reclinable Racing Seats
R850ea



Evo 3 Bike Carrier R495
Thule Range Now In Stock!



Cobra ESD-7570 Laser & Radar Detector - R850



Duplicolor Interior Vinyl & Fabric Spray R90



RaceChip
RaceChip Upgrade Chip
30% More Power! 26% More Torque!
Up to 1l/100km fuel
less consumption!
Racechip 1 - R3350
Racechip Pro 2 - R4350
Racechip Ultimate - R6350



Camtec Media Player
with USB & Front Aux
R295



Pioneer DEH-155MP
Front Loader with Front
Auxiliary input R695



Paramount DVD with
7" Screen & USB - R2250



Sony CDX-G1151u Mp3
Front Loader with USB &
Front Auxiliary R795



ICE Power DVD/Mp3
Cd Front Loader with
3" Screen R950



JVC KW-R510 Double Din
Mp3 with USB and
Front Auxiliary R1595



Targa Amplifiers
1500w 2channel - R495
3000w 4channel - R695
5000w 4channel - R995



Targa Double Din DVD
with Bluetooth R1795
with GPS Navi R2595



Pioneer
12" 1000w - R495
12" 1400w - R580
12" 1400w DVC - R695



Roofmount Screens
7" - R795
8.5" - R850
13" - R1295
12" - R1095
15.4" - R1695
17" - R2100
19" - R2800
22" - R2995



Starting Grid
Starting Grid Audio
Combo - includes:
4000w 4ch Amp,
12" 1200w Subwoofer
+ 12" Sub Enclosure
+ 300w Tweeters
+ 600w 6x9" Speakers
R1195set



15" Evo Lumar Alloys
4/100 & 4/114pcd
R3395 set of 4



Evo BBS Alloy Wheels
4/100, 4/108, 5/100 & 5/114
15" R3395 | 17" R4495



17" Evo Questa Alloys
4/100pcd
R4395 set of 4



Evo Catania Alloy Wheels
4/100 & 4/114pcd
15" R3495 | 17" R4395



Mg032 VW Style Alloys
5/100 & 5/112pcd
17" R4995 | 18" R5795



17" Fox Legend Alloys
4/100 pcd
R4295 set of 4

DUNLOP YOKOHAMA PIRELLI WANLI accelera KENDA EVO

WHEEL & TYRE FITMENT CENTRE OPEN SEVEN DAYS!
Opposite Autostyle JHB Store.
ALLOY WHEEL & TYRE FITTING, BALANCING, STRIPPING

ALL OUR ALLOY WHEELS ARE SUPPLIED "COMPLETE" INCLUDES BOLTS, NUTS, SPIGOTS, CENTER CAPS, VALVES AND VALVE CAPS

13 & 14" TYRES

155/70/13" - Dunlop - R450
155/80/13" - Dunlop - R420
175/50/13" - Yokohama - R850
175/70/13" - Dunlop - R399
175/70/13" - Sava - R425
165/80/13" - Sava - R370

175/65/14" - Dunlop - R480
175/65/14" - Pirelli - R570
175/70/14" - Kenda - R590
185/60/14" - Dunlop - R530
185/60/14" - Pirelli - R650
185/65/14" - Dunlop - R560

15 & 16" TYRES

185/65/15" - Dunlop - R650
195/50/15" - Sava - R540
195/50/15" - Dunlop - R620
195/50/15" - Pirelli - R740
195/50/15" - Yokohama - R680
195/55/15" - Dunlop - R680
195/60/15" - Pirelli - R750
195/60/15" - Dunlop - R670
195/65/15" - Dunlop - R640
205/60/15" - Dunlop - R730

195/45/16" - Wanli - R720
205/45/16" - Kenda - R740
205/55/16" - Yokohama - R795
205/55/16" - Dunlop - R780
225/55/16" - Dunlop - R930

17" & 18" TYRES

205/45/16" - Kenda - R740
205/40/17" - Wanli - R620
205/40/17" - Dunlop - R695
205/40/17" - Pirelli - R920
205/40/17" - Yokohama - R895
215/45/17" - Kenda - R780
225/45/17" - Accelera - R895
225/45/17" - Yokohama - R1150
235/45/17" - Wanli - R890

215/35/18" - Accelera - R980
225/40/18" - Wanli - R895
225/40/18" - Dunlop - R950
225/40/18" - Yokohama - R1295
235/40/18" - Kenda - R1450
255/35/18" - Wanli - R1150

4x4, 19" & 20"

225/35/19" - Yokohama - R1695
235/35/19" - Achilles - R1295
235/35/19" - Yokohama - R1695
265/30/19" - Accelera - R1900
225/30/20" - Wanli - R1295

Bakkie and 4x4/SUV Tyres
195R14" - Wanli - R780
215/R15" - Dunlop - R1200
195R15C - Dunlop - R1050
235/65/17" - Wanli - R1295
275/40/20" - Achilles - R1850
275/45/20" - Achilles - R1850

WINNING TIP

LIGHTING ON THE CHEAP

For cheap emergency lighting at home, use 12 V LED lights that you can pick up for under R20 at 4x4 accessory shops.

I positioned some in my home, unobtrusively alongside my alarm system's PIR sensors. The wires run neatly next to the alarm wiring, through the existing holes in the ceiling. I even wired one into the light fitting in the bathroom.

To switch on the lights, I use a remote switch/dimmer control, bought from the same accessory shop (R120). This negates the wiring needed for a normal switch. I put the control out of sight in a cupboard and I can switch it on from almost anywhere in my townhouse.

Since I don't have an extra battery or charger, for power I simply wired into the back-up battery of my alarm system. The four light units and 14 m of 0,75 mm² flex draw 0,27 Ah. This doesn't tax the battery during the typical two-hour loadshedding period.

The light that this system provides is not strong enough to read by, but it is fine for cooking, etc. The whole lot, including the flex, cost me R260.

ABRI DE WET
BRACKENFELL

DENIM DAMPS THE SQUEAK

When your vehicle's anti-roll bar/stabiliser bar bushes start squeaking and moaning, you'd be inclined to head to a garage to quieten them down. If they are not worn most garages will apply rubber grease, which will attract dust, turn into a grinding paste and accelerate wear.

I came up with a neat tip and my vehicle has covered 74 000 kilometres without a squeak since I carried it out. Take off the bushes and, if they are the split type, cut a section out of a pair of old denim jeans to slightly wider than the bush and long enough so that it can wrap right around the bar, without overlapping it. Glue it to the rubber bush inside with a few drops of superglue and refit the bush. The denim is tough and wears slowly. The plus point is that you will never hear your suspension moan again.

IVAN LULES
BATHURST

SOLDER: THE RIGHT MEDICINE



Solder for small projects often comes in little coils that easily become tangled up. After rewinding messed-up solder for the umpteenth time, I decided to make another plan. I took a small pill bottle and drilled a 2,5 mm hole in the

bottom. Then I threaded one end of the coil through the hole and closed the cap. It works like a charm!

JAKOBUS DE WET
VIRGINIA

EXTENDING BLADE LIFE

I use a very basic fixed arm scroll saw with which I do many small cutouts from 3 to 6 mm in supawood. However, cutting thin material uses only a short section of the blade's length and, when this area gets blunt, it becomes difficult to cut curves.

Good-quality blades are expensive. So, to prolong their life, I have cut a piece of 16 mm melamine to the same dimension as the scroll saw table. Drilled and slotted to fit around the blade, this is then mounted on or clamped to the scroll saw table, which now raises the cut height to use a sharper section of the same blade and doubles the cutting life.

JOHN ROBB
HOWICK KZN

DON'T HEAT, HAMMER

If you need to forge a piece of metal so small that heating it would be kind of a waste of charcoal or gas, place it atop a bench vice and hammer it down using a smallish hammer, without heating it. Be careful not to break your vice – use the fixed end.

CHRISTIAN STEYN
BY EMAIL **PM**

SEND US YOUR HINT – AND SCORE!

Send us your best home, garage workshop and general DIY hints – and win! This month's best tip will receive a Masterlock hamper worth R1 500. The hamper consists of an Armour high security lock, weatherproof Excell™ padlock and high security chain. The high security lock features an armoured rectangular body shape with secure horizontal locking to make the shackle even more difficult to break. It's ideal for securing basement storage units, factory fences or store front gates. For the Excell™ padlock, Master Lock used the toughest boron alloy material and cutting-edge technology and registered more than 40 patents. This is a truly high-security padlock that is 50 per cent stronger than a standard padlock. In laminated steel and available in different sizes, it's suited for indoor and outdoor applications, from securing factory fences to locking sheds or store front gates. Rounding off this security package are pre-cut high security chains made of intrusion-resistant hardened steel and steel alloy. Perfect for securing residential gates or garden furniture, these chains are encased in vinyl to prevent scratching your equipment. For more information on Master Lock, view www.mackiediy.co.za or call 021 508 1250

Send your tips to:

PM Do It Your Way, Box 180, Howard Place 7450, or e-mail popularmechanics@ramsaymedia.co.za. Please include your name, address and contact number. Regrettably, only South African residents are eligible for the prize. Prizes not claimed within 60 days will be forfeited.



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